E-WQ-73-1

TENNESSEE VALLEY AUTHORITY

WATER QUALITY IN THE TENNESSEE VALLEY

DIVISION OF ENVIRONMENTAL PLANNING

E-WQ-73-1

TENNESSEE VALLEY AUTHORITY
Division of Environmental Planning
Water Quality Branch

WATER QUALITY IN THE TENNESSEE VALLEY

Chattanooga, Tennessee
June 30, 1973

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DISCUSSION OF TERMS

Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand is the quantity of dissolved oxygen removed from water by biological organisms in the process of decomposing organic materials. The BOD provides a measure of the strength of an organic waste. Values of BOD can be expressed in concentration terms as milligrams per liter, or in terms of added or total stream loads in pounds per day of oxygen demand. The BOD values given in this report are the dissolved oxygen requirements during a standard period of five days at a temperature of 20° C.

Turbidity

Turbidity is matter suspended in water, such as clay, silt, and microscopic organisms, that cause it to appear cloudy or muddy, rather than clear. Turbidity is measured by the degree to which the suspended matter interferes with the passage of light through the liquid.

Color

Color in water should not be confused with turbidity. True color is caused by material in solution, not by material in suspension. Suspended matter must be removed before the true color determination is made. The color values in this report are expressed in standard platinum cobalt units and provide a measure of the visual aesthetic acceptability of water for various uses. Natural color in surface water is derived primarily from decaying vegetation, particularly from forests, which imparts a yellow-brownish appearance to the water. Color may also be introduced into water by wastes from industrial operations, such as textile dyeing plants and pulp and paper mills.

Dissolved Oxygen (DO)

Dissolved oxygen is the free (chemically uncombined) oxygen in an aqueous solution. In a sense, the dissolved oxygen is simply "mixed" into the liquid. There is a limit to the amount of gaseous oxygen that water can hold in solution, depending upon the temperature of the water and the atmospheric pressure existing at the location and time. Fish and other aquatic organisms require this dissolved gas to carry on life processes.

Fecal Coliform Bacteria

All natural waters contain a wide variety of bacteria that originate from the soil and from living or dead plants and animals. These bacteria generally are without sanitary significance. Conversely, pathogenic or disease-producing bacteria usually are introduced into the aquatic environment by sewage discharges. It is the presence of these disease-producing bacteria that has special public health significance.

While it is possible to isolate and identify specific bacteria, it is not practical to do so in routine tests for water quality. Instead, tests are made for "indicator" organisms, which are present in much larger numbers than pathogenic bacteria. These "indicator" bacteria serve as evidence of the possible presence of those that cause disease.

The most suitable test available for this purpose is identification of bacteria in the "coliform" group—a group which includes micro-organisms of both fecal and nonfecal origin. Fecal coliforms are among the micro-organisms present in both human and animal wastes; they are found in sewage and in surface runoff. Recently developed laboratory techniques allow a distinction to be made between fecal and nonfecal coliforms. This laboratory technique, which gives a reliable estimate of the number of fecal coliforms in a sample, is used by TVA. The presence of significant concentrations of fecal coliforms is evidence of the possible presence of disease-producing bacteria.

Hardness

Hard water is that which requires considerable amounts of soap to produce a foam or suds. Other undesirable effects of hard water are injury to fabrics, interference with some industrial processes, and deposition of scale in hot water heaters and boilers, causing fuel waste. In natural water, hardness is attributable principally to calcium and magnesium ions and is derived largely from contact with soil and rock formations, particularly limestone. Certain industrial wastes also contribute significantly to hardness. The principal minerals causing hardness in order of their relative abundance in natural waters are calcium, magnesium, strontium, and ferrous iron.

pH

pH is a term used to express the intensity of the acid or alkaline condition of a solution. In pure water the concentration of hydrogen ions exactly equals the concentration of hydroxide ions. Such a solution is neutral with a pH of 7. An acidic water (containing excess hydrogen ions) will have a pH less than 7, while an alkaline water (containing excess hydroxide ions) will have a pH greater than 7. Most of the inland streams in the United States that support a good fish population have a pH in the range of 6.5 to 8.5.

7-day, 10-year Minimum Streamflow

The 7-day, 10-year minimum streamflow is the minimum average flow existing for seven consecutive days and that occurs with a statistical frequency of one year in every ten-year period.

Waste Treatment

Primary Treatment—Primary treatment is conventional treatment that removes a major portion of the suspended and floating material from a waste. This is usually accomplished by coarse screening, sedimentation, skimming, and solids disposal. Primary treatment of a domestic waste usually removes approximately 30 percent of the BOD of the waste.

Secondary Treatment—Secondary treatment consists of some form of biological process, normally applied to the liquid effluent from primary treatment, to accomplish oxidation of the remaining suspended and dissolved organic materials. Common biological oxidation processes include trickling filters, activated sludge, and stabilization ponds. Stabilization ponds, which are also commonly called oxidation ponds or lagoons, are usually used to treat sewage that has not received primary treatment. These processes are used for the treatment of sewage and industrial wastes of a type amenable to purification by biological processes. Secondary treatment, combined with primary treatment, can remove about 85-90 percent of the BOD of domestic waste.

Tertiary Treatment—Tertiary treatment consists of additional conventional secondary treatment processes applied after the waste has been subjected to conventional primary and secondary treatment. An example of this is a stabilization pond following conventional activated sludge treatment. Tertiary treatment of a domestic waste, combined with primary and secondary treatment, should remove some 92-95 percent of the BOD.

Advanced Treatment—Advanced waste treatment usually refers to processes, techniques, or systems that provide very high levels of treatment. These are not presently in common use in the wastewater treatment field. Advanced treatment techniques, if used at all, are usually applied after conventional treatment, but they may modify or replace one or more steps comprising present conventional treatment.

SUMMARY

Overall, the streams of the Tennessee Valley are clean, yet stream pollution is a serious problem in some locations. For reference, it has been estimated that 3,300 miles of streams in the Valley have a 7-day, 10-year minimum flow greater than 25 cubic feet per second. During low flows, water quality conditions in 63 reaches of streams and reservoirs, totaling 987 miles in length, need improvement for one or more desirable uses. Seventy-seven percent of these 987 stream miles is in streams that have 7-day, 10-year minimum flows greater than 25 cubic feet per second. Thus, water quality needs improvement in about 23 percent of the stream miles in the Valley that have a minimum flow of 25 cubic feet per second or more.

Of all the desirable uses presently or potentially adversely affected by pollution, propagation of warmwater fish is the one most extensively affected. In the Valley as a whole, the conditions necessary for the continuing growth and vitality of warmwater fish species are not attained in some 583 miles in 41 stream reaches. Use of streams as sources of water supplies ranks second—38 reaches totaling 522 stream miles. Nonwater-contact recreation is third—9 reaches totaling 141 stream miles. Water-contact recreation is fourth—7 reaches totaling 86 stream miles. Management of coldwater fish is least affected—10 reaches totaling 73 stream miles. The locations of stream and reservoir reaches where present or potential water uses are affected by water quality conditions, with the exception of some small streams, are shown in figure I-1. The appendix of this report contains a selection of maps and figures showing water supplies, waste discharges, stream conditions, and observed qualities of water throughout the Tennessee Valley.

There are seven major tributary basins in the Valley. Of these, the Holston and French Broad contain more stream miles degraded by pollution than the others—227 and 199 miles respectively. Thus, these two tributary valleys, which represent only 22 percent of the drainage area of the Valley, account for about 43 percent of all the stream miles in the entire Valley where quality needs improvement.

Before July 1, 1971, the most serious single source of pollution in the Valley (based on miles of stream affected) was an industrial plant located at Saltville, Virginia. Dissolved chlorides, calcium, and sodium in the waste from this plant rendered some 80 miles of the North Fork Holston River unfit to be used as a source of water supply. Water quality in nearly 40 miles below the confluence of the north and south forks of the Holston River was seriously degraded. In addition, water in many more miles of the lower Holston and upper Tennessee Rivers was adversely affected by this waste. On July 1, 1971, the industrial process that was the source of this chemical waste was closed permanently.

It is impossible in several cases to separate the effects of industrial pollution from those of municipal pollution where both types occur within the same stream reach; however, the industrial pollution that can be specifically identified seriously affects 464 stream miles (over 47 percent) of the 987-mile total. Similarly, municipal pollution (including industrial waste discharged to the municipal systems) affects 193 stream miles (over 20 percent) of the 987-mile total. The dissolved oxygen content in about 290 miles of streams below 14 TVA dams and 2 other dams is seasonally affected by releases of water from the lower levels of the reservoirs behind such dams.

Since 1969, a new problem—mercury contamination—has received widespread attention after the Food and Drug Administration, in May 1970, announced specific guidelines for allowable concentrations of mercury in the flesh of fish. Fish that contain mercury in excess of these guidelines have been found in the North Fork Holston River, Pickwick Landing Reservoir, and in Kentucky Reservoir. Although releases from the known

major sources of mercury have been reduced to acceptable levels, TVA is continuing a program of sampling and analysis to monitor the anticipated reduction in concentrations found in bottom sediments and the flesh of fish taken from these waters.

Each of the seven Tennessee River Basin states has an active program for control of water pollution. In accordance with the Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965, all states in the Tennessee River Basin held public hearings and adopted water quality criteria, implementation plans, and stream use classifications. All of the Valley states have now received approval by the Environmental Protection Agency of their water quality standards for interstate streams.

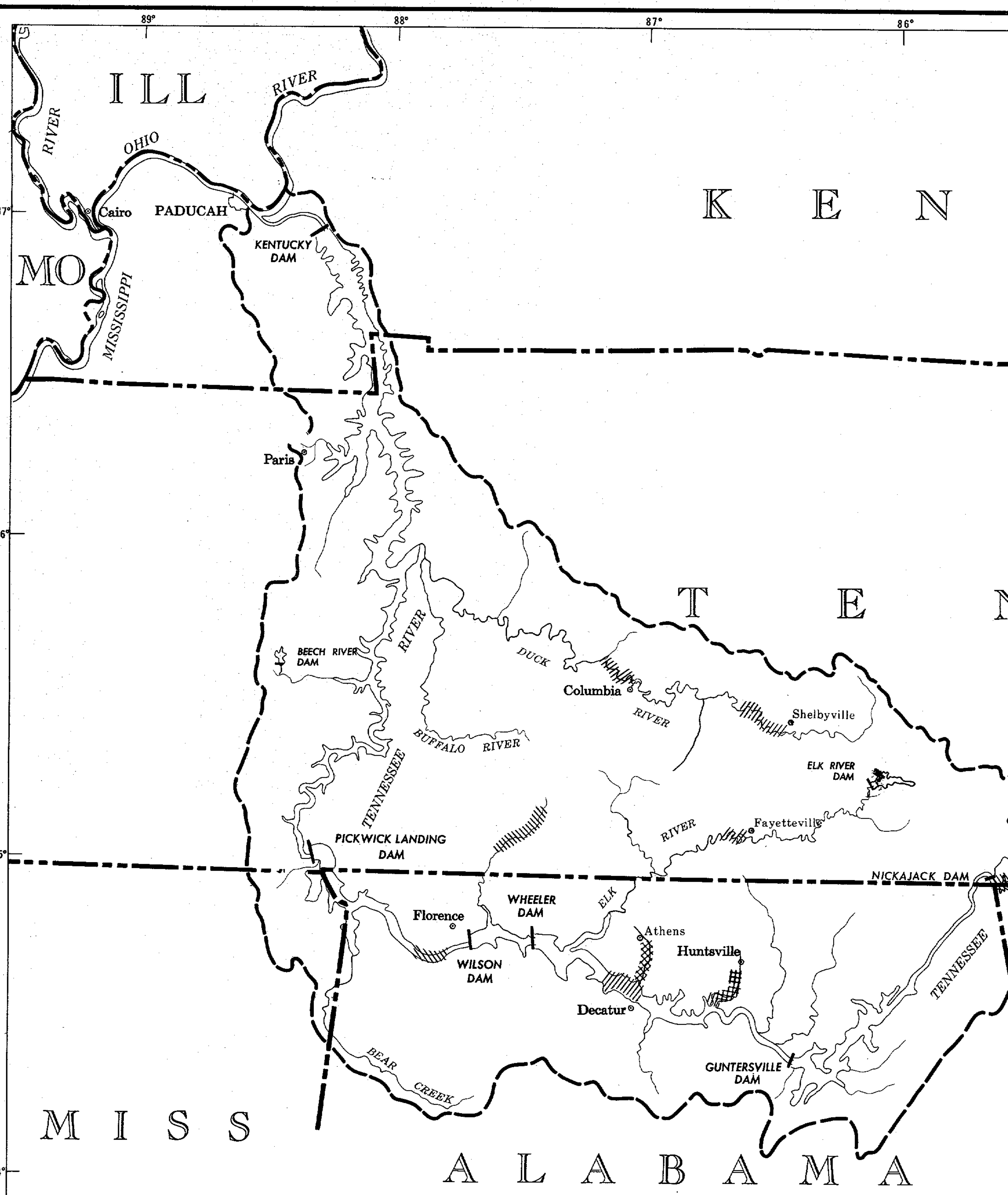
In order to have a uniform set of criteria to apply to streams throughout the Valley, TVA's water quality criteria were used in preparing this report. A tabular comparison of state and TVA water quality criteria is presented in the text. State and TVA criteria differ mainly with regard to temperature, dissolved oxygen, and coliform bacteria requirements.

The fact that a stream reach has not been designated in this report as degraded does not imply that all municipalities, industries, and other potential sources of pollution along that reach are meeting the basic waste treatment requirements.

At present, the major needs for pollution control in the Valley are in the area of industrial waste. Control of the detrimental effect from these point sources of waste is vested with the state stream pollution control agencies. Each Valley state utilizes a permit system for waste discharges. Under these systems, implementation plans for pollution abatement are developed for each source of waste in the Valley. Municipal sewerage systems are accepting an ever-increasing proportion of industrial waste, however. This practice complicates abatement of pollution in some situations.

The detrimental effects from mining and agricultural runoff are also of concern to management of water quality in the Tennessee River Basin. Considerable background work is needed in each of these broad, yet serious areas of impact on water quality.

Many structures for contolling water flow benefit the management of water quality. The present operation with varying releases from these structures creates a complex problem in the management of water resources. TVA is investigating various means of attaining and maintaining acceptable levels of dissolved oxygen in the releases from these structures.



Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.

Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.

Some serious local pollution conditions not shown.

TYPES OF USES

Water Supplies
Propagation of Warmwater Fish
Non-Water-Contact Recreation
Water-Contact Recreation
Management of Coldwater Fish

89° 88° 87° 86°

Figure I-1

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

REACHES OF STREAMS NEEDING IMPROVEMENT IN WATER QUALITY

JANUARY 1969

WATER QUALITY IN THE TENNESSEE VALLEY[1]

Introduction

TVA, as a resource development agency, has been concerned with water quality for many years because of its importance to the optimum utilization of natural resources for economic and social well-being in the Tennessee Valley. In 1966, TVA undertook a basin-wide survey of water quality in the Tennessee Valley to help in the development of a comprehensive plan for water quality management. The objective of the plan was to assure that optimum levels of water quality for desired uses would be maintained where in existence and reached where not.

Section 3 of Public Law 84-660 required the Federal Water Pollution Control Administration, now the Office of Water Programs, Environmental Protection Agency, to prepare pollution control programs in cooperation with other Federal and state agencies, and with municipalities and industries involved. These plans are now a state responsibility, in accordance with the provisions of Title 18, Code of Federal Regulations. This report provides much of the basic information required in forming comprehensive plans for the Tennessee Valley area. It was prepared by TVA with the assistance and cooperation of the Southeast Region, Environmental Protection Agency. In addition, each of the seven Valley states supplied information and basic data. This report describes the level of water quality existing in all sizable streams and impoundments in the Tennessee Valley as of January 1969. It includes a statement of water quality objectives for the Valley that TVA considers necessary if the water resource is to meet fully all of the water needs of the people and to provide the greatest possible net benefit to the region. The report points out stream reaches where water quality is below desired levels and the individual source or groups of sources of the pollutants that produce these conditions. Since it was desirable to have a uniform set of water quality criteria to guide in assessing water quality conditions in the entire Tennessee Valley, only TVA water quality objectives and criteria were used for comparative purposes.

However, from information provided in the report, stream reaches where improvements are required to meet other selected criteria or standards can easily be determined. Complete data on the volume and strength of industrial wastes discharged to Valley streams are not yet available. Consequently, only the population equivalent of domestic wastes are shown on the maps of waste water discharges and stream conditions contained in the appendix. In addition, not all sources of industrial waste shown on these maps are discussed in the text.

This report presents essentially the water quality situation in the Tennessee Valley as of January 1969. However, because of the time lapse since January 1969, it has been necessary to update certain important items. For example, tabular comparison of state and TVA water quality criteria is current as of November 1972.

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1. This report is a summary of a more detailed three-volume draft report "Comprehensive Plan for Water Quality Management in the Tennessee Valley," subtitled "Water Quality, Including Needed Improvements, in the Tennessee Valley—1969" prepared by TVA in January 1969.

The Water Resource of the Valley

The Tennessee River drains an area of nearly 41,000 square miles. Portions of seven states—Virginia (8 percent of the basin area), North Carolina (13 percent), Georgia (4 percent), Tennessee (55 percent), Alabama (17 percent), Mississippi (1 percent), and Kentucky (2 percent)—lie within its boundaries (figure I-2). The topography of the watershed varies greatly. Rugged, forested mountains dominate the eastern portion of the Valley; rolling hills and relatively flat farmlands lie to the west. From Mount Mitchell, towering 6,600 feet above sea level near the eastern boundary of the watershed in North Carolina, the elevation of the land surface ranges downward to Paducah, Kentucky, its northwestern extremity, only a little over 300 feet above sea level.

The mountainous eastern portion of the Valley in North Carolina is drained by the French Broad, the Little Tennessee, and the Hiwassee Rivers. The section of the Valley in southwest Virginia is drained by the Holston and Clinch Rivers and their tributaries. Long, generally parallel ridges and valleys characterize the Valley in southwest Virginia and eastern Tennessee. From the point west of Chattanooga where the Tennessee River flows into northeastern Alabama to its mouth at Paducah, Kentucky, the Tennessee River and its major tributaries in the western half of the Valley—the Elk and Duck Rivers—generally drain areas of rolling hills and flat farmlands.

Precipitation and Runoff

The Valley receives ample precipitation, and due to moderate climate, nearly all of this precipitation is in the form of rainfall. Although there is a rainy season—the winter and early spring months—rainfall is reasonably well distributed throughout the year. This is an important factor when considering water pollution since pollution problems are always aggravated by unusually low streamflows—particularly during warm weather.

Some records of precipitation in the Valley date back more than 80 years. During the past three decades the collection of basic water data has been intensified, primarily by TVA. These data show that for the Valley as a whole, rainfall averages close to 52 inches a year.

The highest precipitation is recorded in the mountains of the southeastern section of the watershed. There at one location, near Highlands, in North Carolina, 93 inches of precipitation falls in an average year . This mountainous region is also the area of greatest variation in precipitation, with the lowest mean (37 inches) recorded near neighboring Asheville. Elsewhere in the Valley precipitation usually ranges within 5 or 10 inches of the basin's average (figure I-3). More than half of the annual total is received in winter and early spring, from November to mid-April. March is generally the wettest month, although at some locations in the eastern sections of the Valley, mid-summer brings the highest precipitation. Early autumn—September and October—is usually the driest season.

Even more important than rainfall in considerations of stream pollution is runoff—that portion of the rainfall that remains after evaporation and transpiration losses. Water collects in stream channels after either flowing directly over land surfaces or after percolating into the soil, down to the water table, and out into the streams as groundwater flow. Runoff in the Valley varies tremendously from location to location; however, taking the Valley as a whole, during an average year a volume equivalent to 22 inches of rainfall over the entire watershed is discharged from the Tennessee Valley into the Ohio River at Paducah, Kentucky.

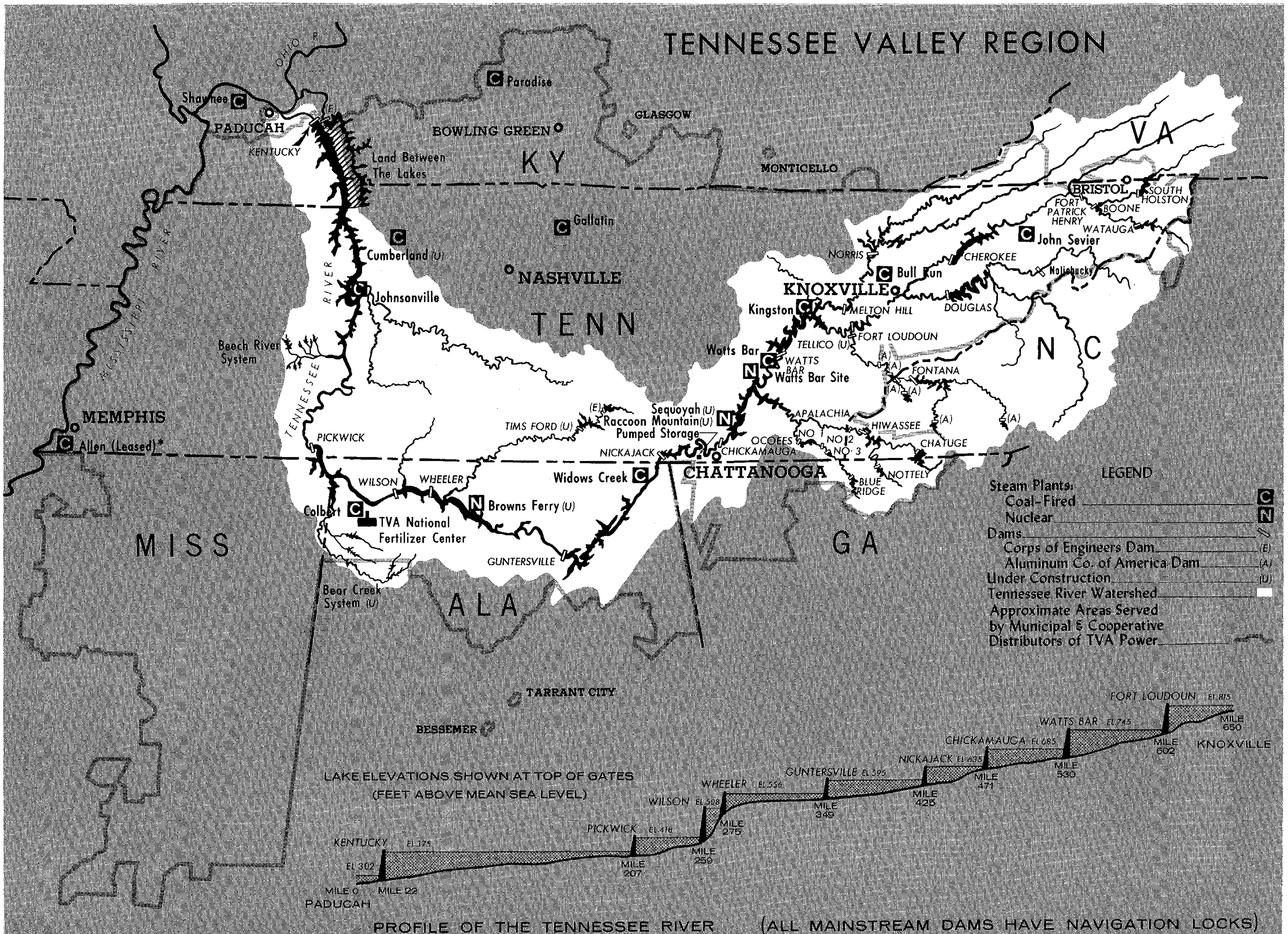

Figure I-2

*Includes gas turbine installation under construction

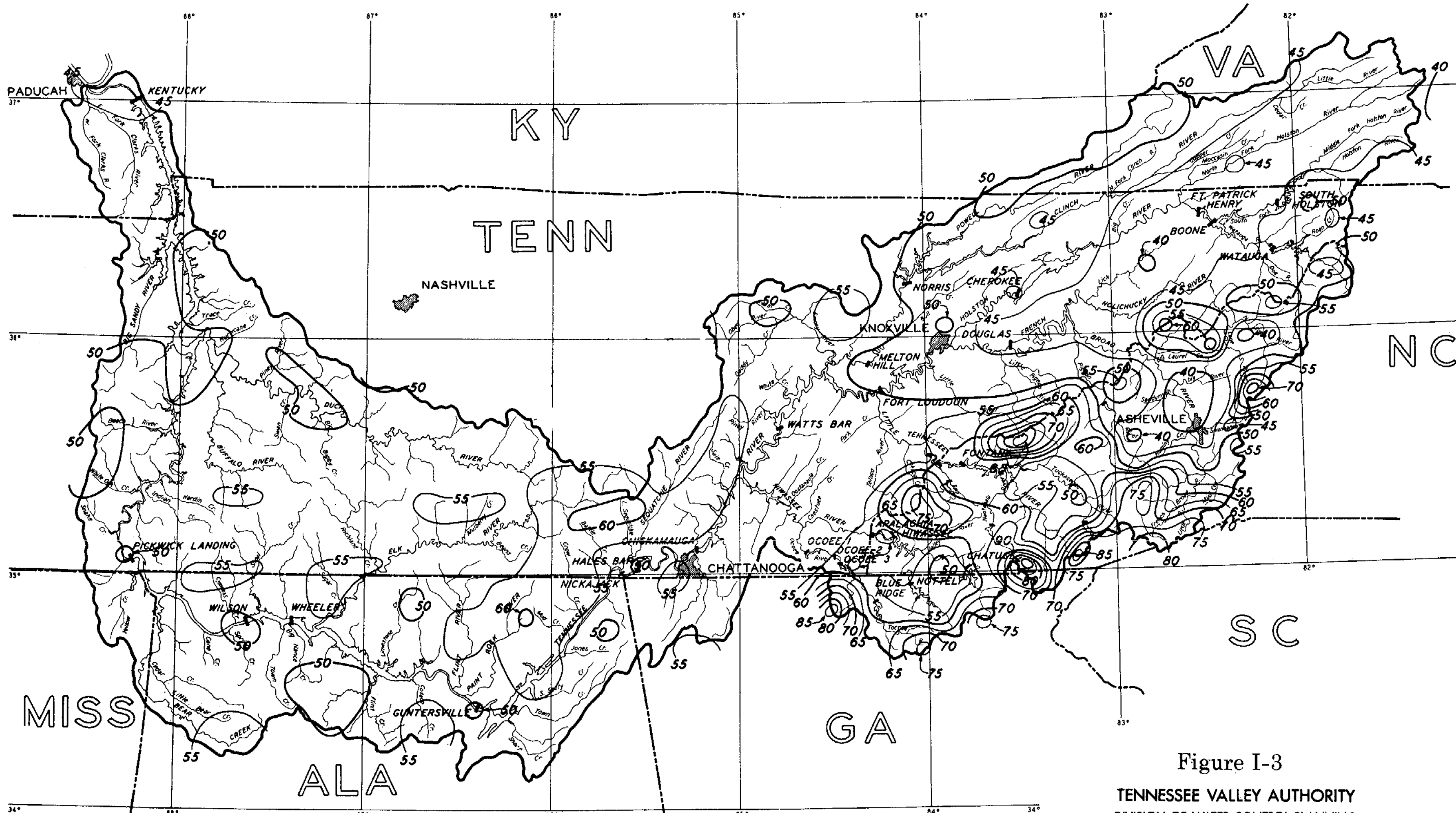

Figure I-3

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

TENNESSEE RIVER BASIN
MEAN ANNUAL PRECIPITATION
30-YEAR PERIOD 1935-1964

SCALE 0 10 20 30 40 50 MILES

SYMBOLS:

- 70 Rainfall in Inches
- State Lines
- Dams
- Dams Under Construction

Demography[1] and Economy

An estimated 3,208,000 people were living in this watershed in 1965. Between 1950 and 1960 the rural-farm population decreased from 35.7 to 17.9 percent of the population, while the urban population increased from 31.9 to 39.0 percent. The estimated 1965 urban and rural-nonfarm population was about 85 percent of the total. In 1960 six population centers accounted for about 40.6 percent of the population. These areas are: Asheville (one county); Bristol-Johnson City-Kingsport (three counties); Knoxville-Oak Ridge (three counties); Chattanooga (two counties); Huntsville-Decatur (two counties); and Florence-Sheffield-Tuscumbia (two counties).

Industrial development has produced this population shift from farms to urban and rural-nonfarm areas. At the end of 1965, manufacturing provided employment for about 333,000 workers. The major manufacturing employers were chemical and allied products (16.1 percent of the manufacturing employment); textile mill products (14.3 percent); and apparel and finished fabric products (13.6 percent). However, the major water using industries—chemical and allied products, primary metals, food and kindred products, and paper and allied products—accounted for 32.6 percent of the manufacturing employment in the Valley.

Stream pollution problems tend to correlate with the concentration of population in towns and cities. Rural areas near the headwaters, which are usually free of industry, rarely have significant problems of stream pollution. In contrast, the very nature of a city creates a potential for stream pollution—not only by domestic sewage but also by industrial wastes originating in manufacturing operations that provide the economic foundation for the city. Timely provision of adequate waste treatment can prevent the development of pollution problems downstream from any municipality or industrial development.

Present Water Uses

Water Supplies

Municipal—About two and one-half million residents, most of the small industries, and many large industries in the Tennessee Valley are supplied with potable water on a 24-hour basis by urban and suburban water systems. Approximately 972 urban and suburban water systems are now operating in the watershed. They use an average of about 286 million gallons per day, an annual total of 320,000 acre-feet. Most of their supply is withdrawn from the watershed streams and rivers; the greatest volume is taken directly from TVA reservoirs. Less than 19 percent of the total used by these systems is supplied from groundwater.

Industrial—For the most part, industries in the watershed are concentrated along the Tennessee River and on certain major tributary rivers—the French Broad, Holston, Hiwassee, and Duck. Their water uses fall into several categories. They need potable water, water for fire protection, and water for sanitary systems. They use water for cooling, boiler makeup, and for process purposes in manufacturing. The "wet" industries—those using large amounts of water for processing and for cooling—include pulp and paper mills, synthetic fiber plants, food processing and canning facilties, and chemical and metal industries.

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1. These figures relate to the 93 counties that most nearly represent the watershed. They should not be confused with other statistics reported for a larger region, such as the 125 counties lying wholly or in part within the watershed.

Use of industrial water in the Valley, not including that supplied and reported by municipal systems and that used for condensing steam in steam-electric power generation, amounts to a minimum of about 1.4 billion gallons per day, or 1.56 million acre-feet per year.

The seven TVA steam-electric power generating stations located in the Tennessee River Basin have a combined total requirement for condenser cooling water of about 7 billion gallons per day. This water passes through the condensers and returns to streamflow. In addition, some relatively minor quantities of water are used for similar cooling by private industries in the Valley.

The heaviest withdrawals of water for mining operations in the Tennessee Valley occur in the Elk River and Duck River Basins where there are phosphate deposits, in the French Board River Basin where mica and feldspar are the principal commercial minerals, and along the Holston River where zinc mines are operating. Some iron ore is mined in Alabama in the Bear Creek Basin. Some marble is quarried near Knoxville, Tennessee, and near Murphy, North Carolina. Some copper is mined in the Hiwassee Basin. Barite deposits are developed near the mouth of the Little Tennessee River, and coal is mined in the Clinch, Emory, and Sequatchie watersheds and along the Tennessee River in northeastern Alabama. Total use of water by all of these operations is relatively small—most of it used for ore washing and flotation.

Agricultural—Water used in the Valley's farm and other rural homes comes almost entirely from wells and springs. Water for watering livestock comes primarily from surface streams and ponds.

Even though the Valley as a whole receives an average of 52 inches of rainfall in a typical year and the climate is considered mild and humid, water for irrigation is still used to increase the productivity of certain farming operations. Whereas in 1964 some 14,100 acres in the Valley were being irrigated, this figure in 1972 was lowered to 11,700 acres. This represents an annual water withdrawal from streams, ponds, and reservoirs of 2.84 billion gallons (8,700 acre-feet) in 1964, and 1.19 billion gallons (3,660 acre-feet) in 1972.

Fishing

Sport Fishing—TVA reservoirs contain more than 625,000 acres of water, essentially all suitable for aquatic life. In addition, some 15,000 miles of streams contribute to and have potential for fish and wildlife development. Many miles of streams in the Valley are considered trout streams. The majority of these lie in the French Broad, Holston, Little Tennessee, and Hiwassee watersheds. The number of 1-day sport fishing trips on TVA waters is estimated at about 10-1/2 million per year; the catch runs between 7,000 and 10,000 tons. Expenditures including the cost of all goods and services required by these fishermen are estimated to be about $93 million annually.

Commercial Fishing—Commercial fishing also contributes to the Valley's economy. In 1971 the commercial harvest of fish was about 3,880 tons, having a value of some $1.45 million. The annual harvest of mussels was estimated at 154 tons, with a value of about $25,000. Four years earlier, in 1967, the mussel harvest amounted to 2,400 tons, with a value of some $430,000.

Recreation

The more than 625,000 acres of water surface and nearly 11,000 miles of shoreline of TVA impoundments receive extensive use for water-based recreation. In 1970 use of the impoundments for swimming, water skiing, boating, and fishing, and of adjacent areas for camping, picnicking, and other leisure time activities resulted in a total of over 47 million visits. In addition to TVA facilities, 97 state, county, and municipal parks along the reservoirs serve the expanding demand for water-based recreation. More than 435 small areas, most of which are under 10 acres in size, have been conveyed to state or local governments to guarantee to the public permanent and unrestricted access to the reservoirs. TVA has transferred 179,000 acres to other public agencies for a variety of recreational uses. This total includes 125,000 acres transferred to Federal agencies and 53,600 acres transferred to state and local agencies. The value of recreation improvements on TVA lakes by private interests and public agencies other than TVA has more than tripled in the past decade and reached a cumulative value of nearly $310 million in June 1970.

Navigation

Navigation is a rapidly expanding use of the water resource. Since 1955 the tonnage on the Tennessee River has more than doubled while the ton-mileage has increased over 60 percent. According to 1968 TVA estimates, traffic amounted to 22.9 million tons and 2.6 billion ton-miles. On a tonnage basis, water transportation carries about 35 percent of all freight shipped to those industries located on the Tennessee River waterfront and 38 percent of the freight shipped from those industries.

Waste Discharges

In this Valley, as elsewhere, both treated and untreated wastes from industries, municipalities, private homes, farms, and even floating craft are discharged to streams and reservoirs. The actual volume of water available for other uses is not reduced by such use of the streams for waste disposal, but where treatment is inadequate, the resultant lowering of water quality can restrict or impair other uses quite severly. More than 308 industries and 484 municipalities, mobile home courts, motels, hospitals, schools, institutions, etc., discharge treated and untreated wastes into streams in the Valley. Before treatment the domestic and industrial wastes (in the municipal sewage) discharged from these 484 sources are equivalent on an organic basis to the untreated sewage from approximately 2,748,000 people. As discharged to the streams, the organic loads are equivalent to the untreated sewage from 984,000 people—representing a reduction in load of about 64 percent.

Extensive use is made of water from streams and reservoirs in the Valley for cooling purposes, principally at TVA's large steam-electric power plants. However, no significant water quality problems associated with discharges of warm water have developed in the Valley.

Water Quality Objectives

TVA Water Quality Objectives

Water quality objectives adopted by TVA are based on the principle that the waters of the Tennessee Valley should be of such quality as to promote and sustain those uses that will result in the maximum net benefit to the people of the region, both now and in the future. TVA's water quality objectives, if attained, should provide the degree of water quality required to promote and sustain those water uses that will result in maximum benefit to the people of the region. These objectives fully recognize the value to the region of protecting water quality to permit all desirable uses and the role that streams serve for final assimilation of treated wastes.

Water quality objectives adopted by TVA apply in unregulated streams to all levels of flow equal to or greater than the 7-day, 10-year minimum. This level of flow is defined as the minimum average flow for seven consecutive days that occurs with a statistical frequency of one year in every 10-year period. This means that only on rare occasions would water quality in natural streams be as low as the values stated in the objectives. The objectives apply to all streamflows in regulated streams, since the flow could be shut off for only a few hours and result in relatively high concentrations of pollution in the low streamflows receiving even well-treated wastes. The objectives apply at all times to impoundments, regardless of the flow that may exist.

TVA's water quality objectives for surface waters in the Tennessee River Basin follow:

> Excluding only those streams having no natural flow in dry weather, all surface waters of the Tennessee River Basin shall be of such quality as to be suitable (1) as sources of municipal, industrial, and agricultural water supplies, (2) for the propagation of warmwater fish, (3) for nonwater-contact recreation, and (4) for all other uses that do not require water of higher qualities.
>
> The waters of all impoundments in the Tennessee River Basin physically suitable and available to the public for recreation shall be of such quality as to be suitable for water-contact recreation. Water quality in certain specified reaches of free-flowing streams, as required in the public interest, shall also be suitable for such recreational usage.
>
> In addition, water in certain specified streams and stream reaches shall be of such quality as to be suitable for management of coldwater fish.

TVA water quality criteria to support these objectives are presented in the tables on pages 11-16.

Stream Classifications Based on TVA Water Quality Objectives

Stream classifications based on TVA water quality objectives are shown in figure I-4. Some of the very small streams designated for management of coldwater fish are not shown. Reaches where improvements in water quality are needed to support uses shown in figure I-4 were presented in figure I-1.

State Water Quality Standards

The Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965, stipulated that the states must hold public hearings and adopt, before June 30, 1967, water quality criteria and plans for implementing and enforcing these criteria for interstate or navigable waters. In accordance with this provision, all states in the Tennessee River Basin held public hearings and adopted water quality criteria, implementation plans, and stream use classifications.

All of the Valley states have now received Environmental Protection Agency approval of their water quality standards for interstate streams.

Comparison of State and TVA Criteria for Water Quality

In order to have a uniform set of criteria to apply to streams throughout the Valley, TVA's water quality criteria were used in preparing this report. A comparison of selected parameters is possible from the following tables[1] which summarize the states' and TVA's

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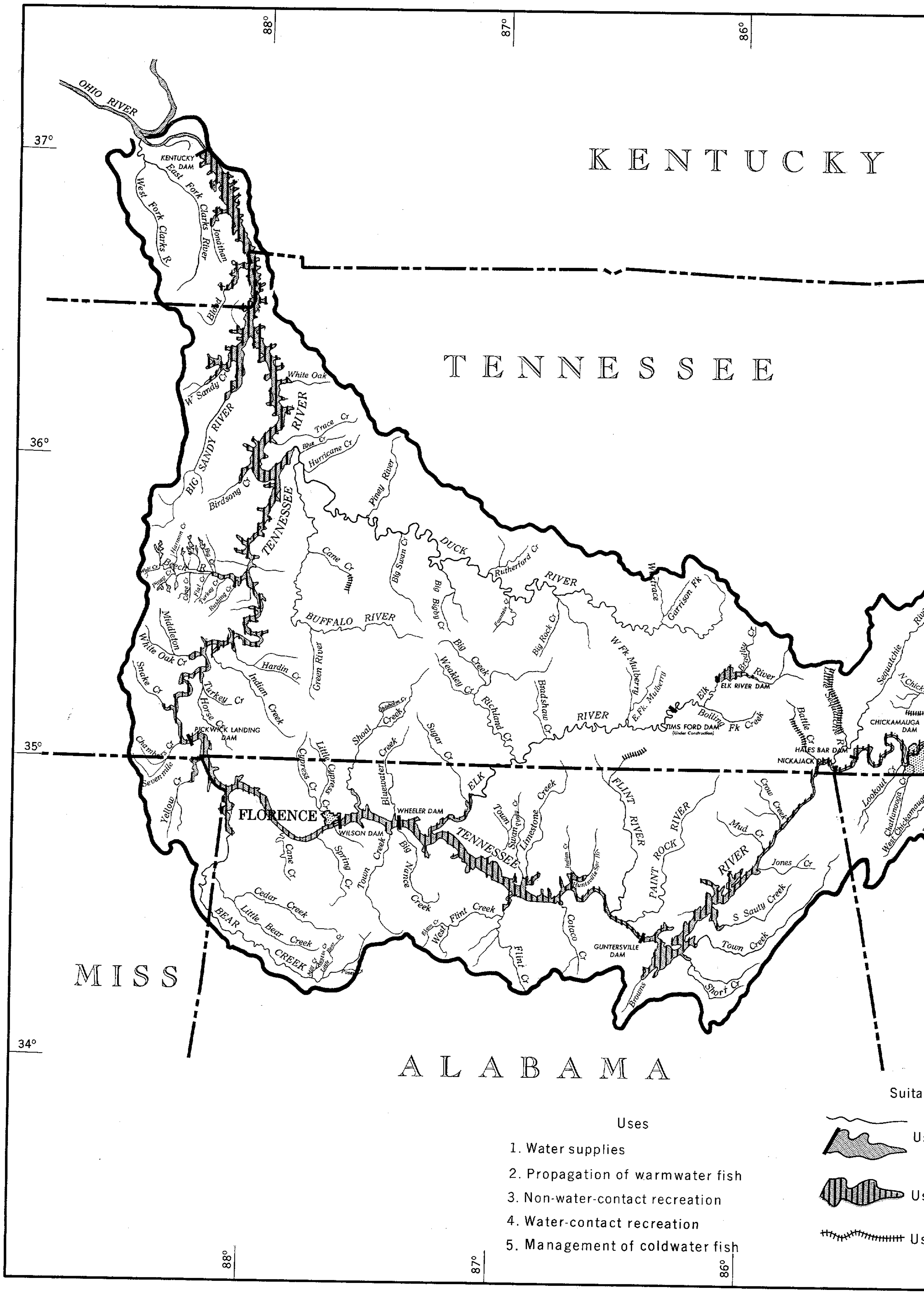
1. The tables are current as of November 1972.


KENTUCKY
TENNESSEE
MISS
ALABAMA
OHIO RIVER
KENTUCKY DAM
East Fork Clarks River
West Fork Clarks R
Jonathan
Blood
W Sandy Cr
BIG SANDY RIVER
Birdsong Cr
White Oak
TENNESSEE RIVER
Trace Cr
Blue Cr
Hurricane Cr
Piney River
DUCK RIVER
Rutherford Cr
Cane Cr
Big Swan Cr
Big Bigby Cr
BUFFALO RIVER
Beech R
Middleton
White Oak Cr
Snake Cr
Hardin Cr
Indian Creek
Green River
Turkey Cr
Horse Cr
PICKWICK LANDING DAM
Chambers Cr
Sevenmile Cr
Yellow Cr
Big Rock Cr
Big Creek
Weakley Cr
Richland Cr
Bradshaw Cr
W Fk Mulberry
E Fk Mulberry
Garrison Fk
Elk River
Bradley Cr
ELK RIVER DAM
Boiling Fk Creek
TIMS FORD DAM (Under Construction)
Battle Cr
Sequatchie R
HALES BAR DAM
NICKAJACK DAM
CHICKAMAUGA DAM
Shoal Creek
Little Cypress Cr
Cypress Cr
Sugar Cr
Bluewater Creek
FLORENCE
WILSON DAM
WHEELER DAM
ELK
Cane Cr
Spring Cr
Town Creek
Big Nance Creek
TENNESSEE
Limestone Creek
Swan Creek
FLINT RIVER
PAINT ROCK RIVER
Crow Creek
Mud Cr
Jones Cr
S Sauty Creek
Town Creek
Short Cr
Browns
GUNTERSVILLE DAM
Cotaco Cr
Flint Cr
Flint Creek
West
Cedar Creek
Little Bear Creek
BEAR CREEK
Lookout Cr
Chattanooga
West Chickamauga
37°
36°
35°
34°
88°
87°
86°
Uses
1. Water supplies
2. Propagation of warmwater fish
3. Non-water-contact recreation
4. Water-contact recreation
5. Management of coldwater fish
Suita

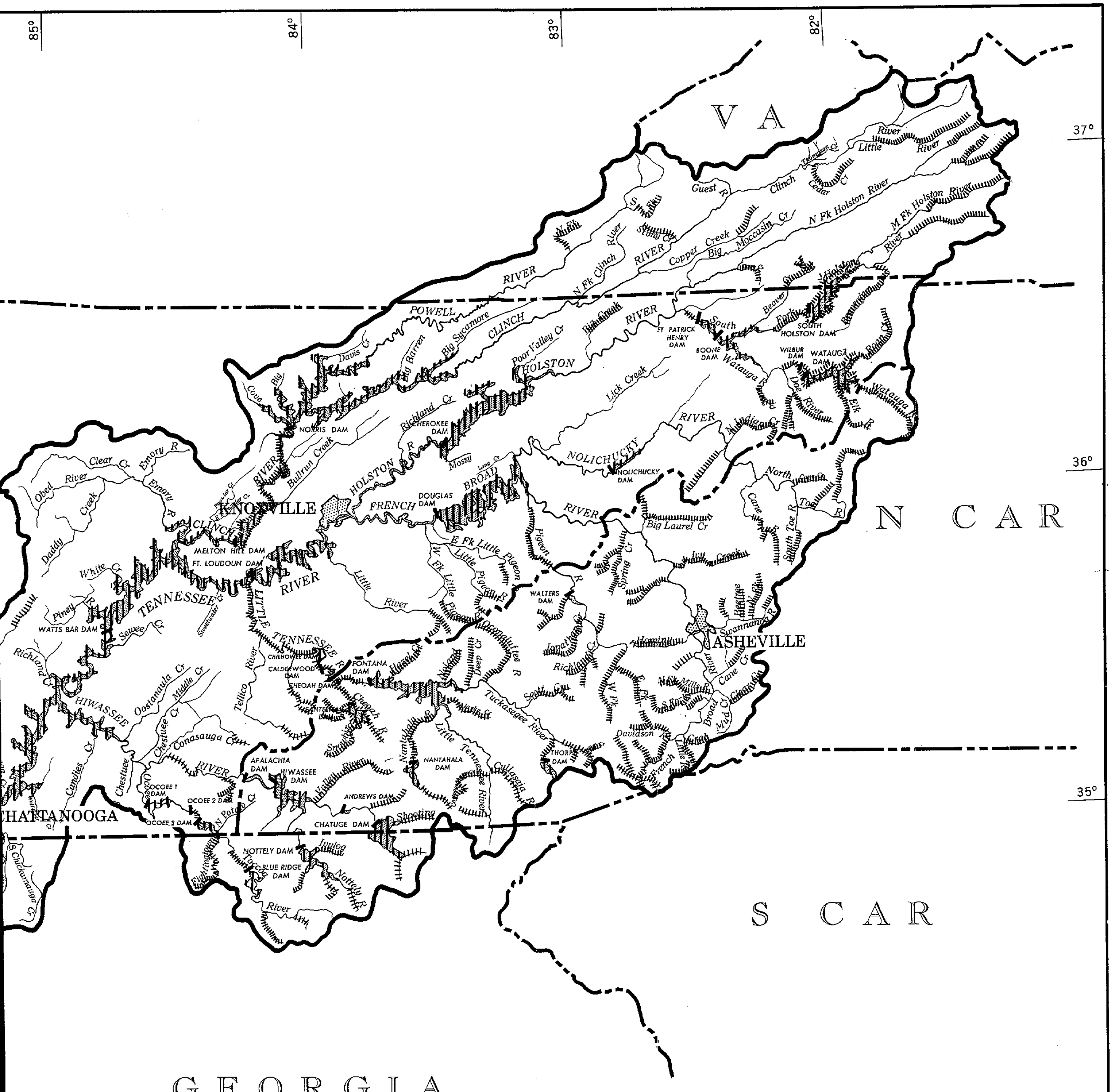


Figure I-4

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

TVA'S STREAM CLASSIFICATIONS

SCALE OF MILES

20 0 20 40 60

JANUARY 1969

e For:

es 1, 2, and 3

es 1, 2, 3, and 4

es 1, 3, and 5

85° 84° 83°

G-HS-301-B-544

STATE AND TVA CRITERIA FOR WATER QUALITY

For Surface Waters Used For

PUBLIC WATER SUPPLY—AFTER COMPLETE TREATMENT

State	pH - Allowable: Range	pH - Allowable: Deviation From Natural	Temperature (°F.) - Allowable: Maximum	Temperature (°F.) - Allowable: Increase Above Natural	Temperature (°F.) - Allowable: Rate of Change	Dissolved Oxygen: Minimum Allowable (mg/1)	Coliforms (per 100 ml) Allowable: Mo. Avg.	Coliforms (per 100 ml) Allowable: Maximum[a]	Radioactivity: Maximum Allowable	Turbidity: Maximum Allowable (JCU)	Color: Maximum Allowable (PCU)	Taste and Odor (Maximum Allowable Phenols in mg/1)	Solids (mg/1) - Allowable: Dissolved	Solids (mg/1) - Allowable: Other	Toxic Substances: Maximum Allowable (mg/1)
Alabama[b] Criteria approved by EPA 9/18/72	6.0-8.5	1.0	86°[c]	5°	-	5.0 5.0-4.0 (range under extreme conditions due to natural causes) 4.0 (due to discharge from existing impoundments)	2,000[d/e] (geometric mean)	4,000[d/f]	None greater than that specified by EPA (USPHS) "Drinking Water Standards."	None of other than natural origin which causes unnatural appearance or interferes with this use. Not to exceed 50 units above background.	Limited to amounts which will not render the water unsuitable for this use or adversely affect the aesthetic value.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment.	After treatment not to exceed EPA (USPHS) "Drinking Water Standards"	Free from waste materials that will settle to form bottom deposits which are unsightly, putrescent, or interfere with this use.	Limited to amounts which will not render the water unsafe or unsuitable for this use.
Georgia Criteria approved by EPA 9/1/72	6.0-8.5	-	90°	5°	-	4.0 5.0 (daily average)	1,000[d/g] (geometric mean)	4,000[d/f]	State and Federal regulations for discharge of radioactive substances must be met.	None from waste discharges which interferes with this use.	None from waste discharges which interferes with this use.	None from waste discharges which interferes with this use.	After treatment not to exceed PHS "Drinking Water Standards"	Free from waste materials which will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable.	Amounts from waste sources limited to levels not harmful to humans, animals, or aquatic life.
Kentucky Criteria approved by EPA 12/23/71	-	-	-	-	-	-	5,000	20%-5,000 5% -20,000	Gross beta limited to 1,000 pCi/1. Dissolved Sr-90 limited to 10 pCi/1. Dissolved alpha emitters limited to 3 pCi/1.	Amounts from waste sources limited to levels which do not create a nuisance.	Free from waste materials which produce color in such degree as to create a nuisance.	Free from waste materials which produce odor in such degree as to create a nuisance. Threshold odor number to be less than 3 after normal treatment.	500 (monthly average) 750 (at any time)	Free from unsightly or deleterious floating debris or other waste materials that will settle to form putrescent sludge deposits.	As-0.05, Ba-1.0, Cd-0.01, Cr^{6}-0.05, Cn-0.025, F-1.0, Pb-0.05, Se-0.01, Ag-0.05. Free from wastes toxic or harmful to human, animal, plant, or aquatic life.
Mississippi[b] Criteria approved by EPA 10/6/72	6.0-8.5	1.0	86°[c]	5°	-	4.0 5.0 (at flows exceeding the 7-day, once-in-10-years flow) 5.0-4.0 (range under extreme conditions for short periods of time)	2,000[d/e] (geometric mean)	4,000[d/f]	Gross beta activity limited to 1,000 pCi/1 (in absence of Sr-90 and alpha emitters).	-	Amounts from waste sources limited to levels not creating nuisance conditions.	Daily average threshold odor limited to 24 (at 60° C.). Phenols: 0.001	500	Amounts from waste sources limited to levels not causing unsightly, putrescent, or objectionable conditions.	As-0.05, Ba-1.0, Cd-0.01, Cr^{6}-0.05, Cn-0.02, Pb-0.05, F-1.2, Se-0.01, Ag-0.05 Free from wastes toxic or harmful to human, animal, or aquatic life.
North Carolina[b] Criteria approved by EPA 1/20/71	Normal for area waters (generally 6.0-8.5). Swamp waters: As low as 4.3.	-	84°	5°	-	4.0 5.0 (daily average) Swamp waters: May be lower than 4.0 if caused by natural conditions.	5,000 1,000[d/e/h] (log mean)	20%-5,000 5%-20,000 20%-2,000[d/h]	Gross beta activity limited to 1,000 pCi/1 (in absence of Sr-90 and alpha emitters).	-	Limited to amounts which will not impair the water for this use.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment. Phenols: 0.001	After treatment not to exceed PHS "Drinking Water Standards"	Amounts from waste sources limited to levels which will not render the water unsafe or unsuitable for this use.	Limited to amounts which will not render the water unsafe or unsuitable for this use.
Tennessee Criteria approved by EPA 6/9/72	6.0-9.0	1.0 (over a 24-hour period)	86.9°[i]	5.4° (relative to an upstream control point)	3.6° (per hour)	Sufficient DO to prevent odors of decomposition or other offensive conditions.	10,000[j]	20%-10,000[j] 5%-20,000[j]	None added in amounts which are detrimental to public health or which will impair the water for this use.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment	500	Limited to amounts which will not impair the usefulness of the water for this use.	Amounts from waste sources limited to levels which will not materially affect man or animals, or impair the safety of a conventionally treated water supply.
Virginia[b] Criteria approved by EPA 2/22/71	6.0-8.5	-	87°	5° 3°[k]	-	4.0 5.0 (daily average)	1,000[d] (log mean)	10%-2,000[d]	Gross beta limited to 1,000 pCi/1. Sr-90 limited to 10 pCi/1. Radium-226 limited to 3 pCi/1.	-	75	Phenols: 0.001	500	Amounts from waste sources limited to levels which will not interefere directly or indirectly with this use.	Specific limits set for many inorganic chemicals, cyanide, pesticides, and herbicides.
Tennessee Valley Authority	6.5-8.5[l]	-	93° (average for any cross section) 95° (any point)	-	-	4.0 (average for any cross section) 3.0 (any point) (Applies only to upper levels of impoundments)[m]	5,000[d/g]	5%-20,000[d] (over a 90-day period)	Not to exceed limits of Public Health Service "Drinking Water Standards."	None shall be added in quantities which may be detrimental to this use.	25 (impounded water) 40 (free-flowing streams)	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment.	500	No distinctly visible solids or waste substances that will form deposits deleterious to aquatic life.	Not to exceed concentration of any chemical substance listed in Public Health Service "Drinking Water Standards."

a. For "Maximum Allowable Coliforms," the percentage notation (e.g., 20%-5,000) means that no more than the given percent (20%) of the samples collected in any month shall exceed the given maximum value (5,000) of coliforms per 100 ml.
b. Only those criteria applicable to streams in the Tennessee River basin are shown.
c. Measured at 5-foot depth or mid-depth if less than 10 feet deep.
d. Fecal coliforms.
e. Not less than 5 samples taken over a 30-day period.
f. In any one sample.
g. Not less than 4 samples taken over a 30-day period.
h. Not applicable during or immediately following periods of rainfall.
i. Impoundments: Measured at 5-foot depths or mid-depth, whichever is less. Streams: Measured at mid-depth.
j. May be exceeded if known to be of nonfecal origin.
k. Applies to the epilimnion of lakes and impoundments.
l. Values above 8.5 acceptable if due to photosynthesis.
m. One-third of maximum cross section depth if less than 45 feet deep; upper 15 feet if over 45 feet deep.

November 1972

STATE AND TVA CRITERIA FOR WATER QUALITY
For Surface Waters Used For
WATER-CONTACT RECREATION

State	pH - Allowable: Range	pH - Allowable: Deviation From Natural	Temperature (°F.) - Allowable: Maximum	Temperature (°F.) - Allowable: Increase Above Natural	Temperature (°F.) - Allowable: Rate of Change	Dissolved Oxygen: Minimum Allowable (mg/l)	Coliforms (per 100 ml) Allowable: Mo. Avg.	Coliforms (per 100 ml) Allowable: Maximum[a/]	Radioactivity: Maximum Allowable	Turbidity: Maximum Allowable (JCU)	Color: Maximum Allowable (PCU)	Taste and Odor: (Maximum Allowable Phenols in mg/l)	Solids (mg/l) - Allowable: Dissolved	Solids (mg/l) - Allowable: Other	Toxic Substances: Maximum Allowable (mg/l)
Alabama[b/] Criteria approved by EPA 9/18/72	6.0-8.5	1.0	86°[c/]	5°	-	5.0 5.0-4.0 (range under extreme conditions due to natural causes) 4.0 (due to discharge from existing impoundments)	200[d/e/f/] (geometric mean)	May exceed mean fecal coliform density of 200 if sanitary survey discloses no significant public health risk in the use of the waters.	None greater than specified by the Criteria and Standards Division, Office of Radiation Protection, EPA.	None of other than natural origin which causes unnatural appearance or interferes with this use. Not to exceed 50 units above background.	Limited to amounts which will not render the water unsuitable for this use or adversely affect the aesthetic value.	Limited to amounts which will not render the water unsuitable for this use or adversely affect the aesthetic value.	-	Free from waste materials that will settle to form bottom deposits which are unsightly, putrescent, or interfere with this use.	Limited to amounts which will not render the water unsafe or unsuitable for this use.
Georgia Criteria approved by EPA 9/1/72	6.0-8.5	-	90°	5°	-	4.0 5.0 (daily average)	200[d/f/g/] (geometric mean)	Lakes and reservoirs: 300[d/f/g/] (geometric mean) Streams: 500[d/f/g/] (geometric mean)	State and Federal regulations for discharge of radioactive substances must be met.	None from waste discharges which will interfere with this use.	None from waste discharges which will interfere with this use.	None from waste discharges which will interfere with this use.	-	Free from waste materials which will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable.	None in concentrations that would harm man, fish, game, or beneficial aquatic life.
Kentucky Criteria approved by EPA 12/23/71	-	-	-	-	-	-	1,000 200[d/h/i/] (May through October) 1,000[d/h/i/] (November through April)	20%-1,000 2,400 (on any day) 10%-400[d/i/] (May through October) 10%-2,000[d/i/] (November through April)	-	Amounts from waste sources limited to levels which do not create a nuisance.	Free from waste materials which produce color in such degree as to create a nuisance.	Free from waste materials which produce odor in such degree as to create a nuisance.	-	Free from unsightly or deleterious floating debris or other waste materials that will settle to form putrescent sludge deposits.	Free from waste substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.
Mississippi[b/] Criteria approved by EPA 10/6/72	6.0-8.5	1.0	86°[c/]	5°	-	4.0 5.0 (at flows exceeding the 7-day, once-in-10-years flow) 5.0-4.0 (range under extreme conditions for short periods of time)	200[d/] (log mean)	10%-400[d/]	-	-	Amounts from waste sources limited to levels which will not render the water unsuitable for this use.	Amounts from waste sources limited to levels which will not render the water unsuitable for this use.	750 (monthly average) 1,500 (at any time)	Amounts from waste sources limited to levels not causing unsightly, putrescent, or objectionable conditions.	Amounts from waste sources limited to levels which will not render the water unsafe or unsuitable for this use.
North Carolina[b/] Criteria approved by EPA 1/20/71	Normal for area waters (generally 6.0-8.5). Swamp waters: As low as 4.3.	-	84°	5°	-	4.0 5.0 (daily average) Swamp waters: May be lower than 4.0 if caused by natural conditions.	200[d/e/j/] (log mean, May through September) 1,000[d/e/j/] (log mean, other months)	20%-400[d/j/] (May through September) 20%-2,000[d/j/] (other months)	Limited to amounts which will not render the water unsafe or unsuitable for this use.	-	Limited to amounts which will not render the water unsuitable for this use.	Phenols: 0.001	-	Amounts from waste sources limited to levels which will not render the water unsafe or unsuitable for this use.	Limited to amounts which will not render the water unsafe or unsuitable for this use.
Tennessee Criteria approved by EPA 6/9/72	6.0-9.0	1.0 (over a 24-hour period)	86.9°[k/]	5.4° (relative to an upstream control point)	3.6° (per hour)	Sufficient DO to prevent odors of decomposition or other offensive conditions.	-	1,000[d/] In any two consecutive samples taken during May through September.	None shall be added in amounts which may be detrimental to recreation.	Amounts from waste sources limited to levels which will not cause an objectionable appearance to the water.	Amounts from waste sources limited to levels which will not cause an objectionable appearance to the water.	Amounts from waste sources limited to levels which will not cause objectionable taste or odor.	-	No distinctly visible solids, bottom deposits, or sludge banks of such size or character that may be detrimental to recreation.	None shall be added which will produce toxic conditions that affect man or animal.
Virginia[b/] Criteria approved by EPA 2/22/71	6.0-8.5	-	87°	5° 3°[l/]	-	4.0 5.0 (daily average)	200[d/] (log mean)	10%-400[d/]	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	-	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.
Tennessee Valley Authority	6.5-8.5[m/]	-	93° (average for any cross section) 95° (any point)	-	-	4.0 (average for any cross section) 3.0 (any point) (Applies only to upper levels of impoundments)[n/]	1,000[d/g/]	-	Not to exceed limits of Public Health Service "Drinking Water Standards."	None shall be added in quantities which may be detrimental to this use.	25 (impounded water) 40 (free-flowing streams)	No wastes shall be added which will result in noticeable offensive odors or otherwise interfere with this use. Phenols: 0.001	500	No distinctly visible solids or waste substances that will form deposits deleterious to aquatic life.	Not to exceed concentration of any chemical substance listed in Public Health Service "Drinking Water Standards."

a. For "Maximum Allowable Coliforms," the percentage notation (e.g., 20%-5,000) means that no more than the given percent (20%) of the samples collected in any month shall exceed the given maximum value (5,000) of coliforms per 100 ml.
b. Only those criteria applicable to streams in the Tennessee River basin are shown.
c. Measured at 5-foot depth or mid-depth if less than 10 feet deep.
d. Fecal coliforms.
e. Not less than 5 samples taken over a 30-day period.
f. No less than 24 hours between samples.
g. Not less than 4 samples taken over a 30-day period.
h. Geometric mean based on at least 10 samples per month.
i. Criterion applies only if total coliform criterion is exceeded, and applies to waste discharges, not to the stream.
j. Not applicable during or immediately following periods of rainfall.
k. Impoundments: Measured at 5-foot depth, or mid-depth, whichever is less. Streams: Measured at mid-depth.
l. Applies to epilimnion of lakes and impoundments.
m. Values above 8.5 acceptable if due to photosynthesis.
n. One-third of maximum cross section depth if less than 45 feet deep; upper 15 feet if over 45 feet deep.

November 1972

STATE AND TVA CRITERIA FOR WATER QUALITY

For Surface Waters Used For

FISH PROPAGATION AND WILDLIFE

State	pH - Allowable Range	pH - Allowable Deviation From Natural	Temperature (°F.) - Allowable Maximum	Temperature (°F.) - Allowable Increase Above Natural	Temperature (°F.) - Allowable Rate of Change	Dissolved Oxygen Minimum Allowable (mg/1)	Coliforms (per 100 ml) Allowable Mo. Avg.	Coliforms (per 100 ml) Allowable Maximum[a]	Radioactivity Maximum Allowable	Turbidity Maximum Allowable (JCU)	Color Maximum Allowable (PCU)	Taste and Odor (Maximum Allowable Phenols in mg/1)	Solids (mg/1) - Allowable Dissolved	Solids (mg/1) - Allowable Other	Toxic Substances Maximum Allowable (mg/1)
Alabama[b] Criteria approved by EPA 9/18/72	6.0-8.5	1.0	86°[c]	5°	-	5.0 5.0-4.0 (range under extreme conditions due to natural causes) 4.0 (due to discharge from existing impoundments)	1,000[d/e] (geometric mean)	2,000[d/f]	None greater than specified by the Criteria and Standards Division, Office of Radiation Protection, EPA.	None of other than natural origin which causes unnatural appearance or interferes with this use. Not to exceed 50 units above background.	Limited to amounts which do not adversely affect propagation, impair palatability, cause injury to fish and wildlife, nor impair aesthetic values.	Limited to amounts which do not adversely affect propagation, impair palatability, cause injury to fish and wildlife, nor impair aesthetic values.	-	Free from waste materials that will settle to form bottom deposits which are unsightly, putrescent, or interfere with this use.	1/10 of 96-hour TL_m. Limited to amounts which are not injurious to fish and aquatic life or the propagation thereof.
Georgia Criteria approved by EPA 9/1/72	6.0-8.5	-	90°	5° Trout or smallmouth bass waters: No elevation or depression of temperature.	-	4.0 5.0 (daily average) Trout waters: 5.0 6.0 (daily average)	1,000[d/g] (geometric mean)	4,000[d/f]	State and Federal regulations for discharge of radioactive substances must be met.	None from waste discharges which will interfere with this use.	None from waste discharges which will interfere with this use.	None from waste discharges which will interfere with this use.	-	Free from waste materials that will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable.	Limited to amounts which do not harm man, fish, game, or other beneficial aquatic life.
Kentucky Criteria approved by EPA 12/23/71	6.0-9.0	-	89°	5° (streams) 3° (impoundments) Put-and-take trout waters: No artificial increase above natural temperature.	-	4.0 5.0 (daily average) Put-and-take trout waters: 6.0 (7.0 in spawning areas during spawning season)	-	-	-	Amounts from waste sources limited to levels which do not create a nuisance.	Free from waste materials which produce color in such degree as to create a nuisance.	Free from waste materials which produce odor or other conditions in such degree as to create a nuisance.	-	Free from unsightly or deleterious floating debris or other waste materials that will settle to form putrescent sludge deposits.	1/10 of 96-hour TL_m. Limits for substances that are toxic because of their cumulative characteristics as presently approved by EPA.
Mississippi[b] Criteria approved by EPA 10/6/72	6.0-8.5	1.0	86°[c]	5°	-	4.0 5.0 (at flows exceeding the 7-day, once-in-10-years flow) 5.0-4.0 (range under extreme conditions for short periods of time)	-	-	-	-	Free from waste materials which produce color in such degree as to create a nuisance.	None shall be added that will impair the palatability of fish or unreasonably affect the aesthetic value. Phenols 0.05	750 (monthly average) 1,500 (at any time)	Amounts from waste sources limited to levels not causing unsightly, putrescent, or objectionable conditions.	1/10 of 48-hour TL_m.
North Carolina[b] Criteria approved by EPA 1/20/71	Normal for area waters (generally 6.0-8.5). Swamp waters: As low as 4.3.	-	84° Natural trout waters: 68° Put-and-take trout waters: 70°	5° Natural trout waters: No significant increase due to discharges. Put-and-take trout waters: 3°	-	4.0 5.0 (daily avg.) Natural trout waters: 6.0 Put-and-take trout waters: 5.0 Swamp waters: May be <4.0 if due to natural causes.	1,000[d/e/h] (log mean)	20%-2,000[d/h]	Limited to amounts which will not render the water injurious to fish and wildlife or adversely affect their palatability.	Limited to amounts which will not render the water injurious to fish and wildlife or adversely affect their palatability.	Limited to amounts which will not render the water injurious to fish and wildlife or adversely affect their palatability.	-	-	Amounts from waste sources limited to levels which will not render the water unsafe or unsuitable for fish and wildlife.	Not to exceed values recommended by the National Technical Advisory Committee on Water Quality Criteria.
Tennessee Criteria approved by EPA 6/9/72	6.5-8.5	1.0 (over a 24-hour period)	86.9°[i] Trout waters: 68°	5.4° (relative to an upstream control point)	3.6° (per hour)	5.0[c] 3.0 (in stream sections receiving treated effluents) Trout waters: 6.0	-	-	No wastes shall be added which will be detrimental to fish or aquatic life.	None added in amounts or of such character that will materially affect fish and aquatic life.	None added in amounts or of such character that will materially affect fish and aquatic life.	No substances shall be added which impart unpalatable flavor to fish, cause offensive odors in the water, or interfere with this use.	-	No distinctly visible solids, bottom deposits, or sludge banks of such size or character that may be detrimental to fish and aquatic life.	None shall be added that will produce toxic conditions which affect fish or aquatic life.
Virginia[b] Criteria approved by EPA 2/22/71	6.0-8.5	-	87° Natural trout waters: 70° Put-and-take trout waters: 70°	5° 3°[j]	-	4.0 5.0 (daily avg.) Natural trout waters: 6.0 7.0 (daily avg.) Put-and-take trout waters: 5.0 6.0 (daily avg.)	1,000[d] (log mean)	10%-2,000[d]	-	-	-	-	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.
Tennessee Valley Authority	6.5-8.5[k]	-	93° (average for any cross section) 95° (any point) Coldwater fish: 70° (average for any cross section)	10°[l]	-	4.0 (average for any cross section) 3.0 (any point) Coldwater fish: 5.0 (average for any cross section) (applies only to upper layers of impoundments)[m]	5,000[d/g]	5%-20,000[d] (over a 90-day period)	Not to exceed limits of Public Health Service "Drinking Water Standards."	None shall be added in quantities which may be detrimental to this use.	25 (impounded water) 40 (free-flowing streams)	No wastes shall be added which impart unpalatable flavor to fish, cause offensive odors in the water, or interfere with this use. Phenols: 0.001	500	No distinctly visible solids or waste substances that will form deposits deleterious to aquatic life.	Not to exceed concentration of any chemical substance listed in Public Health Service "Drinking Water Standards" and not to exceed 1/10 of 48-hour TL_m.

a. For "Maximum Allowable Coliforms," the percentage notation (e.g., 20%-5,000) means that no more than the given percent (20%) of the samples collected in any month shall exceed the given maximum value (5,000) of coliforms per 100 ml.
b. Only those criteria applicable to streams in the Tennessee River basin are shown.
c. Measured at 5-foot depth or mid-depth if less than 10 feet deep.
d. Fecal coliforms
e. Not less than 5 samples taken over a 30-day period.
f. In any one sample.
g. Not less than 4 samples taken over a 30-day period.
h. Not applicable during or immediately following periods of rainfall.
i. Impoundments: Measured at 5-foot depth, or mid-depth, whichever is less. Streams: Measured at mid-depth.
j. Applies to the epilimnion of lakes and impoundments.
k. Values above 8.5 acceptable if due to photosynthesis.
l. No specific limitation has been adopted. For planning and design of new facilities, a temperature rise limitation of 10° F. is suggested.
m. One-third of maximum cross section depth if less than 45 feet deep; upper 15 feet if over 45 feet deep.

November 1972

STATE AND TVA CRITERIA FOR WATER QUALITY
For Surface Waters Used For
AGRICULTURAL WATER SUPPLY

State	pH - Allowable		Temperature (°F.) - Allowable			Dissolved Oxygen	Coliforms (per 100 ml) Allowable		Radioactivity	Turbidity	Color	Taste and Odor	Solids (mg/l) - Allowable		Toxic Substances
	Range	Deviation From Natural	Maximum	Increase Above Natural	Rate of Change	Minimum Allowable (mg/l)	Mo. Avg.	Maximum[a]	Maximum Allowable	Maximum Allowable (JCU)	Maximum Allowable (PCU)	(Maximum Allowable Phenols in mg/l)	Dissolved	Other	Maximum Allowable (mg/l)
Alabama[b] Criteria approved by EPA 9/18/72	6.0-8.5	1.0	86°[c]	5°	-	2.0[c]	-	-	None greater than specified by the Criteria and Standards Division, Office of Radiation Protection, EPA.	None of other than natural origin which causes unnatural appearance or interferes with this use. Not to exceed 50 units above background.	Limited to amounts which will not render the water unsuitable for agricultural irrigation or livestock watering.	Limited to amounts which will not render the water unsuitable for agricultural irrigation or livestock watering.	Only amounts which will not render the water unsuitable for this use.	Free from waste materials that will settle to form bottom deposits which are unsightly, putrescent, or interfere with this use.	Limited to amounts which will not render the water unsuitable for agricultural irrigation or livestock watering and fish survival.
Georgia Criteria approved by EPA 9/1/72	6.0-8.5	-	90°	5°	-	3.0	5,000[d/e] (geometric mean)	-	State and Federal regulations for discharge of radioactive substances must be met.	None from waste discharges that will interfere with this use.	None from waste discharges that will interfere with this use.	None from waste discharges that will interfere with this use.	Only amounts which will not interfere with or adversely affect this use.	Free from waste materials that will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable.	None in concentrations or amounts that would interfere with or adversely affect uses for general agricultural purposes and fish survival.
Kentucky Criteria approved by EPA 12/23/71	-	-	-	-	-	-	-	-	-	Amounts from waste sources limited to levels which do not create a nuisance.	Free from waste materials which produce color in such degree as to create a nuisance.	Free from waste materials which produce odor in such degree as to create a nuisance.	-	Free from unsightly or deleterious floating debris or other waste materials that will settle to form putrescent sludge deposits.	Free from waste substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.
Mississippi[b] Criteria approved by EPA 10/6/72	6.0-8.5	1.0	86°[c]	5°	-	3.0	-	-	-	-	Free from waste materials which produce color in such degree as to create a nuisance.	Free from waste materials which produce odor in such degree as to create a nuisance.	750 (monthly average) 1,500 (at any time)	Amounts from waste sources limited to levels not causing unsightly, putrescent, or objectionable conditions.	Free from waste materials in concentrations or combinations which are toxic or harmful to human, animal, or aquatic live.
North Carolina[b] Criteria approved by EPA 1/20/71	Normal for area waters (generally 6.0-8.5). Swamp waters: as low as 4.3.	-	84°	5°	-	3.0	1,000[d/f/g/h] (log mean)	20%-2,000[d/g/h]	Amounts from waste sources limited to levels that will not render the water unsuitable for agricultural use.	Amounts from waste sources limited to levels that will not render the waters unsuitable for agricultural use or cause offensive conditions.	Amounts from waste sources limited to levels that will not render the waters unsuitable for agricultural use or cause offensive conditions.	Amounts from waste sources limited to levels that will not render the waters unsuitable for agricultural use or cause offensive conditions.	-	Amounts from waste sources limited to levels that will not render the waters unsuitable for agricultural use or cause offensive conditions.	Amounts from waste sources limited to levels which will not render the waters unsuitable for agricultural use, fish survival, or cause offensive conditions.
Tennessee Criteria approved by EPA 6/9/72	6.0-9.0	1.0 (over a 24-hour period)	-	Temperature shall not be raised or lowered to such an extent as to interfere with this use.	-	Sufficient DO to prevent odors of decomposition or other offensive conditions.	-	-	None added in amounts which are detrimental to the waters used for irrigation or livestock watering.	-	-	Amounts from waste sources limited to levels which will not interfere with irrigation or livestock watering	Only amounts which will not impair the water for this use.	No distinctly visible solids, bottom deposits, or sludge banks of such size or character as may impair the usefulness of the water for irrigation or livestock watering.	None shall be added which will produce toxic conditions that will affect the water for irrigation or livestock watering.
Virginia[b] Criteria approved by EPA 2/22/71	6.0-8.5	-	87°	5° 3°[i]	-	4.0 5.0 (daily average)	1,000[d] (log mean)	10%-2,000[d]	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.
Tennessee Valley Authority	6.5-8.5[j]	-	93° (average for any cross section) 95° (any point)	-	-	4.0 (average for any cross section) 3.0 (any point) (Applies only to upper levels of impoundments)[k]	5,000[d/e]	5%-20,000[d] (over a 30-day period)	Not to exceed limits of Public Health Service "Drinking Water Standards."	None shall be added in quantities which may be detrimental to this use.	25 (impounded water) 40 (free-flowing streams)	No wastes shall be added which will result in noticeable offensive odors or otherwise interfere with this use. Phenols: 0.001	500	No distinctly visible solids or waste substances that will form deposits deleterious to aquatic life.	Not to exceed concentration of any chemical substance listed in Public Health Service "Drinking Water Standards."

a. For "Maximum Allowable Coliforms," the percentage notation (e.g., 20%-5,000) means that no more than the given percent (20%) of the samples collected in any month shall exceed the given maximum value (5,000) of coliforms per 100 ml.
b. Only those criteria which apply to streams in the Tennessee River basin are shown.
c. Measured at 5-foot depth or mid-depth if less than 10 feet deep.
d. Fecal coliforms.
e. Not less than 4 samples taken over a 30-day period.
f. Not less than 5 samples taken over a 30-day period.
g. Not applicable during or immediately following periods of rainfall.
h. Applies only to waters used for irrigation of fruits and vegetables.
i. Applies to the epilimnion of lakes and impoundments.
j. Values above 8.5 acceptable if due to photosynthesis.
k. One-third of maximum cross section depth if less than 45 feet deep; upper 15 feet if over 45 feet deep.

November 1972

STATE AND TVA CRITERIA FOR WATER QUALITY

For Surface Waters Used For

INDUSTRIAL WATER SUPPLY

State	pH - Allowable		Temperature (°F.) - Allowable			Dissolved Oxygen	Coliforms (per 100 ml) Allowable		Radioactivity	Turbidity	Color	Taste and Odor	Solids (mg/1) - Allowable		Toxic Substances
	Range	Deviation From Natural	Maximum	Increase Above Natural	Rate of Change	Minimum Allowable (mg/1)	Mo. Avg.	Maximum[a]	Maximum Allowable	Maximum Allowable (JCU)	Maximum Allowable (PCU)	(Maximum Allowable Phenols in mg/1)	Dissolved	Other	Maximum Allowable (mg/1)
Alabama[b] Criteria approved by EPA 9/18/72	6.0-8.5	1.0	86°[c]	5°	-	2.0[c]	-	-	None greater than specified by the Criteria and Standards Division, Office of Radiation Protection, EPA.	None of other than natural origin which causes unnatural appearance or interferes with this use. Not to exceed 50 units above background.	Limited to amounts which will not render the water unsuitable for industrial cooling or process water supply purposes.	Limited to amounts which will not render the water unsuitable for industrial cooling or process water supply purposes.	Only amounts which will not render the water unsuitable for this use.	Free from waste materials that will settle to form bottom deposits which are unsightly, putrescent, or interfere with this use.	Limited to amounts which will not render the water unsuitable for industrial cooling or process water supply purposes and fish survival.
Georgia Criteria approved by EPA 9/1/72	6.0-8.5	-	90°	5°	-	3.0	-	-	State and Federal regulations for discharge of radioactive substances must be met.	None from waste discharges which interferes with this use	None from waste discharges which interferes with this use.	None from waste discharges which interferes with this use.	Only amounts which will not render the water unsuitable for this use.	Free from waste materials that will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable.	None in amounts or concentrations that would interfere with this use and fish survival.
Kentucky Criteria approved by EPA 12/23/71	5.0-9.0	-	95°	-	-	-	-	-	-	Amounts from waste sources limited to levels which do not create a nuisance.	Free from waste materials which produce color in such a degree as to create a nuisance.	Free from waste materials which produce odor in such a degree as to create a nuisance.	750 (monthly average) 1,000 (at any time)	Free from unsightly or deleterious floating debris or other waste materials that will settle to form putrescent sludge deposits.	Free from waste substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.
Mississippi[b] Criteria approved by EPA 10/6/72	6.0-8.5	1.0	86°[c]	5°	-	3.0	-	-	-	-	Free from waste materials which produce color in such a degree as to create a nuisance.	Free from waste materials which produce odor in such a degree as to create a nuisance.	750 (monthly average) 1,500 (at any time)	Amounts from waste sources limited to levels not causing unsightly, putrescent, or objectionable conditions.	Free from waste materials in concentrations or combinations which are toxic or harmful to human, animal, or aquatic life.
North Carolina[b] Criteria approved by EPA 1/20/71	Normal for area waters (generally 6.0-8.5). Swamp waters: as low as 4.3.	-	84°	5°	-	3.0	-	-	Amounts from waste sources limited to levels that will not render the water unsuitable for industrial cooling purposes.	Amounts from waste sources limited to levels that will not render the waters unsuitable for industrial cooling purposes or cause offensive conditions.	Amounts from waste sources limited to levels that will not render the waters unsuitable for industrial cooling purposes or cause offensive conditions.	-	-	Amounts from waste sources limited to levels that will not render the waters unsuitable for industrial cooling purposes or cause offensive conditions.	Amounts from waste sources limited to levels that will not render the waters unsuitable for industrial cooling purposes, fish survival, or cause offensive conditions.
Tennessee Criteria approved by EPA 6/9/72	6.0-9.0	1.0 (over a 24-hour period)	86.9°[d]	5.4° (relative to an upstream control point)	3.6° (per hour)	Sufficient DO to prevent odors of decomposition or other offensive conditions.	-	-	None added in quantities that may adversely affect the water for industrial processing.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment.	Amounts from waste sources limited to levels which can be reduced to acceptable levels by conventional treatment.	No substances shall be added which result in taste or odor that would prevent the use of the water for industrial processing.	500	No distinctly visible solids, bottom deposits or sludge banks of such size or character as may impair the usefulness of the waters for industrial water supply.	No substances shall be added which produce toxic conditions that will adversely affect the water for industrial processing.
Virginia[b] Criteria approved by EPA 2/22/71	6.0-8.5	-	87°	5.0 3.0[e]	-	4.0 5.0 (daily average)	1,000[f] (log mean)	10%-2,000[f]	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	-
Tennessee Valley Authority	6.5-8.5[g]	-	93° (average for any cross section) 95° (any point)	-	-	4.0 (average for any cross section) 3.0 (any point) (Applies only to upper levels of impoundments[h])	5,000[f/i]	5%-20,000[f] (over a 90-day period)	Not to exceed limits of Public Health Service "Drinking Water Standards."	None shall be added in quantities which may be detrimental to this use.	25 (impounded water) 40 (free-flowing streams)	No wastes shall be added which will result in noticeable offensive odors or otherwise interfere with this use. Phenols: 0.001	500	No distinctly visible solids or waste substances that will form deposits deleterious to aquatic life.	Not to exceed concentration of any chemical substance listed in Public Health Service "Drinking Water Standards."

a. For "Maximum Allowable Coliforms," the percentage notation (e.g., 20%-5,000) means that no more than the given percent (20%) of the samples collected in any month shall exceed the given maximum value (5,000) of coliforms per 100 ml.
b. Only those criteria which apply to streams in the Tennessee River basin are shown.
c. Measured at 5-foot depth or mid-depth if less than 10 feet deep.
d. Impoundments: Measured at 5-foot depth or mid-depth whichever is less. Streams: Measured at mid-depth.
e. Applies to epilimnion of lakes and impoundments.
f. Fecal coliforms.
g. Values above 8.5 acceptable if due to photosynthesis.
h. One-third of maximum cross section depth if less less than 45-feet deep; upper 15 feet if over 45 feet deep.
i. Not less than 4 samples taken over a 30-day period.

STATE AND TVA CRITERIA FOR WATER QUALITY
For Surface Waters Used For
NAVIGATION

State	pH - Allowable		Temperature (°F.) - Allowable			Dissolved Oxygen	Coliforms (per 100 ml) Allowable		Radioactivity	Turbidity	Color	Taste and Odor	Solids (mg/1) - Allowable		Toxic Substances
	Range	Deviation From Natural	Maximum	Increase Above Natural	Rate of Change	Minimum Allowable (mg/1)	Mo. Avg.	Maximum[a]	Maximum Allowable	Maximum Allowable (JCU)	Maximum Allowable (PCU)	(Maximum Allowable Phenols in mg/1)	Dissolved	Other	Maximum Allowable (mg/1)
Alabama[b] Criteria approved by EPA 9/18/72	5.0-9.5	-	-	-	-	Sufficient to prevent the development of an offensive condition.	-	-	None greater than specified by the Criteria and Standards Division, Office of Radiation Protection, EPA.	None of other than natural origin which causes unnatural appearance or interferes with this use. Not to exceed 50 units above background.	-	Odor producing substances only in such amounts as will not create an offensive condition.	-	Free from waste materials that will settle to form bottom deposits which are unsightly, putrescent, or interfere with this use.	Amounts from waste sources limited to levels which will not render the water toxic or harmful to human, animal, or aquatic life.
Georgia Criteria approved by EPA 9/1/72	6.0-8.5	-	90°	5°	-	3.0	5,000[c/d] (geometric mean)	-	State and Federal regulations for discharge of radioactive substances must be met.	None from waste discharges which will interfere with this use.	None from waste discharges which will interfere with this use.	None from waste discharges which will interfere with this use.	-	Free from waste materials that will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable.	None in concentrations or amounts which would damage vessels or otherwise interfere with commercial navigation and fish survival.
Kentucky[e] Criteria approved by EPA 12/23/71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi[b] Criteria approved by EPA 10/6/72	5.0-9.5	1.5	86°[f]	5°	-	3.0	-	-	-	-	Free from waste materials which produce color in such a degree as to create a nuisance.	Free from waste materials which produce odor in such a degree as to create a nuisance.	1,000 (monthly average) 2,000 (anytime)	Amounts from waste sources limited to levels not causing unsightly, putrescent, or objectionable conditions.	Free from waste materials in concentrations or combinations which are toxic or harmful to human, animal, or aquatic life.
North Carolina[b] Criteria approved by EPA 1/20/71	Normal for area waters (generally 6.0-8.5). Swamp waters: as low as 4.3.	-	84°	5°	-	3.0	-	-	Amounts from waste sources limited to levels that will not render the water unsuitable for navigation.	-	Amounts from waste sources limited to levels that will not render the water unsuitable for navigation or cause offensive conditions.	Amounts from waste sources limited to levels that will not render the waters unsuitable for navigation or cause offensive conditions.	-	Amounts from waste sources limited to levels that will not render the waters unsuitable for navigation or cause offensive conditions.	Amounts from waste sources limited to levels that will not render the waters unsuitable for navigation or cause offensive conditions.
Tennessee Criteria approved by EPA 6/9/72	-	-	-	Temperature shall not be raised or lowered so as to interfere with the waters' use for navigation.	-	Sufficient DO to prevent odors of decomposition or other offensive conditions.	-	-	Limited to amounts not detrimental to navigation.	-	-	-	-	No distinctly visible solids, bottom deposits, or sludge banks of such size or character as to interfere with navigation.	None shall be added which will produce toxic conditions that will affect the water for navigation.
Virginia[b] Criteria approved by EPA 2/22/71	6.0-8.5	-	87°	5° 3°[g]	-	4.0 5.0 (daily average)	1,000[c] (log mean)	10%-2,000[c]	-	-	-	-	-	Amounts from waste sources limited to levels which will not interfere directly or indirectly with this use.	-
Tennessee Valley Authority	6.5-8.5[h]	-	93° (average for any cross section) 95° (any point)	-	-	4.0 (average for any cross section) 3.0 (any point) (Applies only to upper levels of impoundments[i])	5,000[c/d]	5%-20,000[c] (over a 90-day period)	Not to exceed limits of Public Health Service "Drinking Water Standards."	None shall be added in quantities which may be detrimental to this use.	25 (impounded water) 40 (free-flowing streams)	No wastes shall be added which will result in noticeable offensive odors or otherwise interfere with this use. Phenols: 0.001	500	No distinctly visible solids or waste substances that will form deposits deleterious to aquatic life.	Not to exceed concentration of any chemical substance listed in Public Health Service "Drinking Water Standards."

a. For "Maximum Allowable Coliforms," the percentage notation (e.g., 20%-5,000) means that no more than the given percent (20%) of the samples collected in any month shall exceed the given maximum value (5,000) of coliforms per 100 ml.
b. Only those criteria which apply to streams in the Tennessee River basin are shown.
c. Fecal coliforms.
d. Not less than 4 samples taken over a 30-day period.
e. Kentucky has not adopted criteria for this use classification.
f. Measured at 5-foot depth or mid-depth if less than 10 feet deep.
g. Applies to epilimnion of lakes and impoundments.
h. Values above 8.5 acceptable if due to photosynthesis.
i. One-third of maximum cross section depth if less than 45 feet deep; upper 15 feet if over 45 feet deep.

water quality criteria for various water uses. State and TVA criteria differ mainly with regard to temperature, dissolved oxygen, and coliform bacteria requirements.

Considerable commentary is available concerning temperature effects on the propagation of various species of fish and aquatic life; however, authorities do not agree on the maximum temperature limits, deviation from the natural stream temperature, or rate of temperature change desirable to protect fish and associated aquatic life. Expanded research is needed to resolve this problem.

Comparison of Present Conditions With TVA Water Quality Criteria

Overall, the streams of the Tennessee Valley are clean, yet stream pollution is a serious problem. For reference, it has been estimated that there are 3,300 miles of streams in the Valley in which the 7-day, 10-year minimum flow exceeds 25 cubic feet per second. Water quality conditions in 63 stream and reservoir reaches, totaling 987 miles in length, are unsuitable during low flows for one or more desirable uses. Seventy-seven percent of these 987 stream miles is in streams having 7-day, 10-year minimum flows greater than 25 cubic feet per second. Thus, there is need for improvement in quality in about 23 percent of all the miles of streams in the Valley having appreciable flow (minimum flows of 25 cubic feet per second or more).

The effects of adverse water quality on present or potential water uses in the Valley are summarized as follows:

Effects of Adverse W ater Quality Conditions on Water Uses

Summary for the Valley

Use	Number of Stream Reaches Affected	Total Miles Affected
Water supplies	38	522
Propagation of warmwater fish	41	583
Nonwater-contact recreation	8	141
Water-contact recreation	7	86
Management of coldwater fish	10	73
Total for one or more uses	63	987

Since more than one use is affected in many stream reaches, the total number of stream reaches and total miles affected are not the sums of the individual values listed.

Specific Parameters Defining Adverse Water Quality Conditions

Summary for the Valley

Water Quality Parameter	Number of Stream Reaches Affected	Total Miles Affected
Temperature	1	36
Color	7	140
Taste and odor	1	17
Floating and settleable substances	5	43
Fecal coliform bacteria	28	293
Dissolved oxygen*	43	560
pH	3	48
Fluorides	1	3
Toxic substances	9	93
Other chemical substances	7	181
Total for the Valley	63	987

Of all the desirable uses presently or potentially adversely affected by pollution, propagation of warmwater fish is the one most extensively affected. In the Valley as a whole, propagation of warmwater fish is impaired in some 41 stream reaches, totaling 583 stream miles. Use of streams as sources of water supply ranks second—38 reaches totaling 522 stream miles; nonwater-contact recreation is third—8 reaches totaling 141 stream miles; water-contact recreation is fourth—7 reaches totaling 86 stream miles; and management of coldwater fish is least affected—10 reaches totaling 73 stream miles. The locations of stream and reservoir reaches where present or potential water uses are affected by water quality conditions, with the exception of some small streams, are shown in figure I-1. Details for major tributary basins and the subdivisions of the main river are summarized as follows:

One or More Water Uses Affected by Adverse Water Quality Conditions

Summary for Major Tributary Basins and Subdivisions of Main River

Location	Number of Stream Reaches Affected	Total Miles Affected
French Broad River Basin	9	199
Holston River Basin	10	227
Little Tennessee River Basin	4	60
Clinch River Basin	7	67
Hiwassee River Basin	10	107
Elk River Basin	2	12
Duck River Basin	2	25
Local area draining to Tennessee River between Knoxville and Chickamauga Dam	7	146
Local area draining to Tennessee River between Chickamauga Dam and Guntersville Dam	5	71

*There are 14 TVA dams releasing water low in dissolved oxygen that affect 284 miles of streams. In addition, water low in dissolved oxygen released through Cheoah and Walters Dam affects 4 miles of streams.

Location	Number of Stream Reaches Affected	Total Miles Affected
Local area draining to Tennessee River between Guntersville Dam and Pickwick Landing Dam	6	66
Local area draining to Tennessee River between Pickwick Landing Dam and mouth of Tennessee River	1	7

Of the seven major tributary basins in the Valley, the Holston and French Broad are the most seriously polluted in terms of total stream miles affected. The Holston and French Broad contain, respectively, 227 and 199 miles of streams degraded by pollution. Thus, these two tributary valleys account for about 43 percent of all the miles of streams in the entire Valley where improvement in water quality is needed. In terms of drainage area, these two basins account for only some 22 percent of the Valley. A summary of data by states follows:

One or More Water Uses Affected by Adverse Water Quality Conditions

Summary by States

State	Number of Stream Reaches Affected	Total Miles Affected
Alabama	5	39
Georgia	5	29
Kentucky	1	7
Mississippi	0	0
North Carolina	13[a]	187[b]
Tennessee	41[c]	625[d]
Virginia	4	100
Total	63[e]	987

a. Two of the 13 reaches are continuous interstate reaches originating in Georgia.

b. Of the total 187 miles affected, 23 miles is the result of pollution sources in Georgia.

c. Four of the 41 reaches are continuous interstate reaches originating in other states—in North Carolina, in Georgia, and in Virginia.

d. Of the total 625 miles affected, 87 miles is the result of pollution sources in other states—37 miles from North Carolina sources, 41 miles from Virginia sources, and 9 miles from Georgia sources.

e. The continuous interstate reaches are shown in each state total but are counted only once in the overall total.

Computations of assimilative capacity indicate that the provision of secondary treatment for wastes entering some deleteriously affected stream reaches will not sufficiently reduce the waste loads to achieve TVA's water quality objectives. The streams thus affected and the communities or industries discharging waste material to them are as follows:

Stream Reaches, Affected Primarily by Municipal Waste Discharges, That Will Not Meet TVA's Water Quality Objectives With the Provision of Only Secondary Treatment

Stream	Municipality[1]
Beaver Creek	Bristol, Tennessee
Big Rock Creek[2]	Lewisburg, Tennessee
Cypress Creek[2]	Calvert City, Kentucky
East Fork Clarks River[3]	Murray, Kentucky
Huntsville Spring Branch	Huntsville, Alabama
Obed River	Crossville, Tennessee
Rock Creek	Tullahoma, Tennessee
Swan Creek	Athens, Alabama
Town Branch and Mud Creek	Russellville, Alabama
West Chickamauga Creek	Chickamauga, Georgia

1. These municipalities presently utilize secondary waste treatment facilities.
2. This stream has no natural flow during dry periods of the year.
3. The 7-day, 10-year minimum flow is zero at Murray, Kentucky.

Stream Reaches, Affected by Both Municipal and Separate Industrial Waste Discharges, That Will Not Meet TVA's Water Quality Objectives With the Provision of Only Secondary Treatment

Stream	Municipality and Industry
Duck River	Columbia, Tennessee E. I. duPont de Nemours & Co., Inc.
Duck River	Shelbyville, Tennessee Dixie Home Poultry Corporation
South Fork Holston River	Kingsport, Tennessee Mead Corporation Tennessee Eastman Company Holston Army Ammunition Plant

Stream Reaches, Affected Primarily by Industrial Waste Discharges, That Will Not Meet TVA's Water Quality Objectives With the Provision of Only Secondary Treatment

Stream	Industry
Cane Creek	Beaunit Fibers and Amtex, Incorporated, at Etowah, Tennessee
Hominy Creek	American Enka Corporation at Enka, North Carolina
Nolichucky	American Enka Corporation at Lowland, Tennessee
Pigeon River	Champion Papers, Inc., at Canton, North Carolina

Until July 1, 1971, the most serious single source of pollution in the Valley (based on miles of stream affected) was an industrial plant at Saltville, Virginia. Dissolved chlorides, calcium, and sodium in the waste from this plant rendered some 80 miles of the North Fork Holston River unfit as a source of water supply. Water quality in nearly 40 miles of the upper Holston River was seriously degraded. In addition, water in many more miles of the lower Holston and upper Tennessee Rivers was adversely affected by this waste. In July 1970, the Virginia State Water Control Board adopted water quality standards for the North Fork Holston River that limited the concentration of dissolved solids in the river below the chemical plant to 500 mg/l. The management of the plant determined that the standard could not be met and decided to close on July 1, 1971, that portion of the plant from which the major chemical wastes originated. As of June 30, 1972, the remaining plant operations had been phased out.

It is impossible in several cases to separate the effects of industrial pollution from municipal pollution where both types occur within the same stream reach; however, the industrial pollution that can be specifically identified seriously affects 460 stream miles (47 percent) of the 987-mile total. Similarly, municipal pollution (including industrial waste discharged to the municipal systems) affects 200 stream miles (20 percent) of the 987-mile total. The dissolved oxygen content in about 290 miles of streams below 14 dams and 2 other dams is affected by low-level water releases from such dams.

Major Problem Areas

Among the Valley's major water quality problems, the most urgent needs are in the broad areas of industrial waste treatment and municipal waste collection and treatment. Others of major concern to basinwide water quality are control of detrimental effects of urban runoff, mine drainage, agricultural runoff, and stream control structures. The following discussion briefly describes conditions within each of the major problem groups and the needs associated with each.

Industrial Waste

The effectiveness of methods for abating industrial water pollution within the Valley encompasses the entire spectrum of achievement. In recent years, industry in general has made a positive response, although its capacity to do so has varied tremendously. For more than a decade, the basin's industrial growth has exceeded the national rate, and a major contributing factor has been the abundance of good water. Since the role of water undoubtedly will be greatly expanded in the future, examination of present and potential problem areas must envision conditions that a preponderance of industries will create that use great amounts of water in the Valley.

The principal industrial problems are centered on established users of large volumes of water and the relatively small industries whose water demands are substantial. The slow progress in pollution abatement achieved by established industries that use large volumes of water can be exemplified by comparing the findings of a 1952 TVA stream pollution report with the present status.

The 1952 report noted that eight major industries in the Valley provided no treatment for their wastewater before discharging it to the receiving streams. Two of these industries have installed facilities for separating and treating concentrated wastes before discharge; two have installed facilities for partial removal of heavy metals, plus sedimentation; one has changed the location of its waste outfall from a tributary stream to the main channel of the Tennessee River; one has installed secondary waste treatment; and one has modified its manufacturing process in order to reduce its organic waste load, but is now planning to phase out its operations. The eighth industry has discontinued operations rather than provide treatment for its waste.

Relatively small industries that use sizable quantities of water—the second broad industrial category—are numerous and distributed throughout the basin. When located in isolated areas, the water quality problems they create are usually fairly localized. The availability of high quality water was often a major consideration in selection of the plant site.

Plants located in urban centers either are discharging to minor streams, a local major stream, or to public sewerage systems. In the latter case, the problem of controlling pollution is complicated because frequently municipal sewerage systems have only limited capacity for treating and monitoring industrial waste.

Municipal Waste

Municipalities and special sewerage districts dealing with demands for disposal of urban wastewater face seemingly endless problems. Facilities to adequately treat municipal wastewater loads, including a substantial portion of industrial waste, are managed, financed, and operated by individual local governments. There are five standard metropolitan statistical areas with populations of 100,000 and greater within the Valley, each utilizing various approaches to implementing wastewater treatment needs. In addition, about 170 communities are served by some system of wastewater collection and treatment. This does not include such institutions as schools, hospitals, prisons, camps, and small independent sewerage districts that maintain their own facilities.

In many cases these communities lack the population density or resource base required for efficient administration of a modern sewerage system, even though their wastewater disposal needs are substantial. In too many cases, treatment plants that were properly designed and constructed do not serve their full purpose because they are improperly operated. In metropolitan areas, wastewater collection and treatment can present special problems because of the multiplicity of political jurisdictions frequently involved. This is the case in the metropolitan areas of Chattanooga and Knoxville, Tennessee.

The Chattanooga urban area receives drainage from two entire Georgia counties, a major portion of a third Georgia county, and an extensive sewerage system designed to serve the major part of the tributary drainage area. However, six small incorporated communitites within the area, three of which are within the area of Chattanooga's present interceptor service, provide some form of independent sewerage service. Chattanooga has added secondary treatment units to its main sewage plant at Moccasin Bend that have a design capacity of 42 million gallons daily. The basic plant was accepted on July 28, 1971, but completion of the plant is being held in abeyance pending completion of certain contracts by subcontractors. Presently, 68 percent of the organic loading to this plant is of industrial origin.

The city of Chattanooga is engaged in a series of annexation programs in Hamilton County. At present, approximately 103,000 people within the county, or about 39 percent of the population, are without sewerage service. A study was made of the county's sewerage needs, and a master plan was proposed for that portion of the area tributary to Chattanooga. The proposed engineering plan, utilizing Chattanooga's interceptor sewerage system, was presented to the county council in early 1967.

Walker County, Georgia, also prepared an engineering report covering the northern portion that is tributary to Chattanooga. This section of the county has been without sewerage service, except for a segment of the city of Rossville which for years has had a working agreement with Chattanooga. The city of Chattanooga reached a formal agreement with Walker County to accept sewage flow from the entire tributary drainage area into its interceptor sewers.

Catoosa County, Georgia, where 17,000 of the total 23,700 population are without waste treatment facilities, retained a consulting engineering firm to develop a master sewerage plan for the entire county. The plan has been completed and submitted to the State Health Department and Federal agencies for approval.

The third Georgia county draining into the Chattanooga area is Dade, a sparsely populated county. It has only one small incorporated community where sewerage and sewage treatment facilities were completed in late 1971.

In the case of Knoxville, an annexation sewerage program is nearing completion. This program, which includes expansion and addition to Knoxville's sewerage and sewage treatment facilities, was funded through extensive revenue bonds. Roughly 71 percent of greater Knoxville's 186,000 population is served by waste treatment facilities. During 1968 the city placed two secondary sewage treatment plants into operation. About 80 percent of the present organic loading in the city's 36-million-gallon-per-day main treatment plant is of industrial origin.

Knoxville's annexation program has been limited to Knox County. During recent years there has been rapid residential development in the western part of the county. Much of this area drains away from the city to the Clinch River. Development has also been rapid in the southern part of the county, which, along with the Knoxville urban area, drains to the Tennessee River's Fort Loudoun Reservoir. Because of poor subsurface drainage characteristics, the Federal Housing Administration withdrew its approval for further development of these rapidly growing western and southern parts of Knox County until proper sewerage facilities could be provided. Of Knox County's 82,800 population outside the Knoxville city limits, only 7,900 are served by sewerage and waste treatment facilities.

There are in Knox County seven small public utility districts that provide water supply and a few that provide some sewerage service. Following the Federal Housing Administration's action, several of the districts proposed to undertake sewerage service for themselves, but there was strong opposition to this approach on the basis that effective planning and utilization of resources could not be realized on such a small scale. The Metropolitan Planning Commission is evaluating all service needs of all areas in Knox County. The findings will be used to determine the feasibility of the city's annexing all or part of the study areas.

Blount County's principal drainage system is the Little River, which enters an embayment of Fort Loudoun Reservoir just below Knoxville. The only sewerage service in the county is provided by two incorporated communities—Alcoa and Maryville. These two communities are contiguous; however, each maintains its own collection and treatment facilities, and each discharges its waste to Pistol Creek at outfalls about six miles apart. By 1975 these communities will be served by a new regional plant located on Little River with discharge to the Tennessee River.

An example of consolidated wastewater management in a major community is found in Asheville, North Carolina. For many years, the Asheville metropolitan area has been a major contributor to water quality problems that have plagued the upper French Broad River. To cope with the problem, the North Carolina State Stream Sanitation Committee in January 1962 established the Metropolitan Sewerage District of Buncombe County. This action combined the sewerage systems of the city of Asheville, the towns of Biltmore Forest, Weaverville, and Black Mountain, and ten sanitary districts operating within the county.

In December 1963 the district's voters approved a bond issue totaling $10,400,000. It was a general obligation bond issue, carrying the full faith and credit of the district, payable from an unlimited ad valorem tax, and additionally secured by a pledge of the net revenues of the district's sewerage system. The Enabling Act authorized and empowered the district to (a) acquire, lease, construct, extend, maintain, and operate any sewerage system within or without the district; (b) issue and secure its general obligation bonds or revenue bonds; (c) fix, revise, and collect rents and fees for use of sewerage service; and (d) make and enter into contracts with governing bodies of any political subdivisions for sewerage service.

By early 1968 the district had completed and put into operation a 25-million-gallon-per-day sewage treatment plant, whose interceptor sewer system serves the major metropolitan area (98 percent of the district's waste), and a small collection and treatment system that serves the Weaverville community.

Urban Runoff

Urban runoff, a problem that is national in scope, is detrimental to water quality and difficult to control. This is reflected in the 1966 Clean Water Restoration Act, which authorizes specific research and development grants to deal with the problem. Projects currently funded under this authorization range from the development of automated control systems to demonstrating the effectiveness of holding ponds in stabilizing combined sewer overflow or heavily infiltrated wastewater.

As might be expected, the greatest impact on water quality from urban runoff is in metropolitan areas. Of particular concern is the feasibility of attaining the water quality required for water-contact recreation. Some sections of the collection systems of both Knoxville and Chattanooga have combined storm and sanitary sewers, and, in addition, there is considerable seepage of ground water into the cities' older sanitary sewers. Both metropolitan areas drain to reservoirs—Knoxville to Fort Loudoun and Chattanooga to Nickajack—that carry use classification for water-contact recreation. Separating storm water and waste water systems or providing storage lagoons to retain peak flows can be extremely costly. In addition, Knoxville has very limited available land for an interceptor lagoon at the site of its main treatment plant. Chattanooga has had engineering studies made and has purchased land for such a lagoon at its main plant.

Since urban runoff has very high bacteriological counts, storage of these combined storm and sanitary wastes during periods of high flows following storms would greatly improve conditions in Nickajack, but the adequacy of these measures remains to be determined. Improvement of bacteriological conditions in Fort Loudoun will be much more difficult because of limitations on plant sites and because an extensive portion of the population of the metropolitan area is without sewerage service.

Neither Asheville, North Carolina, nor Huntsville, Alabama, has combined sewers in its collection system, but extensive infiltration is common to both. Although the French Broad River is not classified for contact recreation throughout its length in North Carolina, completion of Buncombe County's metropolitan sewage plant has improved the bacteriological quality below Asheville. The high infiltration rate badly needs to be corrected to protect the district's great investment in its interceptor sewer and treatment capacity.

Huntsville, faced with a similar problem of infiltration, purchased television equipment to inspect its sewers, a move that has proved effective in identifying major joint and pipe problems. Because of rapid growth of the city's sewer system, coupled with limited maintenance and repair crews, the overall reduction of infiltration is very difficult. The bacteriological effects of Huntsville urban runoff and extensive sewer infiltration have the greatest impact on Huntsville Spring Branch and Indian Creek embayment of Wheeler Reservoir. The state of Alabama has classified the section of Wheeler Reservoir from Indian Creek downstream to Flint Creek for water-contact recreation.

Many other areas of the Valley have similar bacteriological problems. Decatur, Alabama—where water is classified for water-contact recreation but present quality is unsuitable—plans to construct secondary treatment facilities at its waste disposal plant in the near future.

Mine Drainage

There is extensive mining activity throughout the basin. Phosphate is extracted in the Duck and Elk Basins, and mica, feldspar, and clay are mined in the French Broad Basin. Zinc mines operate in the Holston Basin, and iron ore is mined in Alabama's Bear Creek Basin. Marble is quarried near Knoxville, Tennessee, and near Murphy, North Carolina. There are copper mines in the Hiwassee Basin. Barite deposits are mined in the lower Little Tennessee River area, and coal is mined in the Clinch, Emory, and Sequatchie watersheds and along the Tennessee River in northern Alabama.

These mining activities can impair water quality in two ways. First, there is the problem of siltation, which is common to most mining activities. Second, there is the problem of acid drainage, which is related primarily to coal mining.

In improperly managed strip mining, siltation occurs by erosion of the removed overburden and unreclaimed mined areas. The discharge from ore processing is another source of silt. Sedimentation, which is the normal method used to remove silt from the ore-processing waste, often creates massive volumes of tailings that can also be subject to runoff and erosion. Gravel and coal washeries and limestone sawmills and crushers also can contribute to problems of siltation and turbidity. Portable operations that remove sand and gravel from stream beds disturb many local areas since they are moved frequently to decrease haul distances.

The effects of silt and sediment on aquatic flora and fauna vary with species and with concentrations of pollutants. Fine silt may stay in suspension; large particles blanket the stream bottom and smother desirable aquatic life. Silt and sediment reduce light transmittance, absorb organic and other substances and thereby cause further depositions, and may alter temperature gradients.

The mining and processing of feldspar, mica, and clay cause turbidity and siltation in North Toe and South Toe Rivers in the French Broad Basin. The extent of this problem has not been fully assessed. Water supply dictates the location of processing plants adjacent to the rivers. The massive tailings from these operations are deposited in adjacent diked areas to reduce hauling distances. A typical mica processing plant normally operates around the clock, six days a week, and processes 600 tons of raw ore daily to obtain 60 tons of product.

Extensive phosphate mining in the Duck River Basin impairs water quality of the river from Columbia to its mouth. The problems are turbidity and siltation from strip- or area-mining runoff and ore-processing operations. In all cases the ore-processing plants operate large tailing ponds into which their mining wastes flow for sedimentation before being discharged to the Duck River or its tributaries; however, the overflows generally contain fine, suspended materials.

Ocoee River's "copper basin" offers a striking example of the effects of mining and ore extraction on water quality. Because of large quantitites of process waste discharged to the Ocoee River by Tennessee Copper Company (now Cities Services Company), and excessive erosion in the "copper basin," the combined effects of acid water and siltation have seriously impaired the aquatic life in the three Ocoee Reservoirs. Often the pH is below the TVA criterion of 6.5 (fish and aquatic life) from the waste source to the confluence with the Hiwassee River, a distance of about 37 miles.

Acid mine drainage also is causing a problem in the Emory River Basin. Acid is formed from drainage of active and abandoned coal mines, but is confined to the basin's minor tributaries.

There are indications of acid mine drainage in some tributaries of the Clinch River in Virginia and Tennessee, of the Sequatchie River, and of some tributaries draining into Nickajack Reservoir. The magnitude has not been fully assessed, but indications are that it is minimal at this time.

Since 1965 there has been a surge of legislation for reclamation of strip mines within the Tennessee River Basin. Kentucky enacted its reclamation law in 1954 and amended it in 1956, 1960, 1964, 1965, and 1966; Virginia enacted its law in 1965 and amended it in 1968; Tennessee and Georgia enacted their laws in 1967; Alabama and North Carolina enacted their laws in 1969 and 1971, respectively. To date Mississippi is the only Valley state that has not passed any specific legislation for reclamation of strip mines. Since 1965

TVA has required its coal contractors to provide reclamation including water control measures during and after mining to minimize erosion and to replant all land disturbed by the mining process. In 1971 TVA tightened its reclamation requirements to include a mining plan as well as more stringent standards. State legislation in some cases requires posting of performance bonds and obtaining yearly permits to ensure compliance with the law.

There have not been sufficient studies since passage of the reclamation laws to fully determine their effectiveness in controlling pollution from mining activities. Extensive biological studies in the major mining areas of the Valley can determine the extent of fish food-chain effect and help identify need for further regulatory action.

Agricultural Runoff

Agricultural runoff presents various problems to water quality management, one of the major ones being the relative uncontrollability of some sources of pollution. Runoff and seepage from agricultural land enter water-courses over widespread areas in contrast to point sources of waste from municipal and industrial sewerage systems. As a result, the effects of agricultural runoff are generally more subtle than those from municipal or industrial sources and at times are attributed to "background" conditions.

Agricultural runoff may contain silt, organic material, bacteria, pesticides, and nutrients—each of which may impair water quality for some beneficial use.

Silt effects noted under the discussion of mine drainage are applicable to agriculture; in addition, silt may act as a vehicle to transmit such pollutants as pesticides, nutrients, bacteria, and toxicants.

Sources of organic material in agricultural runoff include surface drainage from cattle feedlots and other areas where animals are concentrated in relatively large groups, excreta deposited by domestic and wild animals either at the edge or directly into bodies of water, drains from animal quarters and milking rooms, seepage from silos, runoff from manured fields, and effluents from animal waste disposal lagoons.

In the French Broad River Basin, one feedlot operation located adjacent to the Nolichucky River handles 10,000 cattle annually. Waste from a herd of this size is estimated to be equivalent to domestic waste from a town of 165,000 people.

The trend toward fewer farms and larger herds points to a greater need for controlling waste from these sources. The magnitude of the problem is indicated by the fact that on a national level the waste strength from farm animals is estimated to be 10 times that of the human population. As a step toward dealing with this, stabilizing lagoons and irrigation systems are being tried on a limited scale to treat waste from feedlot operations; however, the effectiveness of these systems needs to be evaluated, and other methods need to be devised to deal with this increasing problem.

Surveys in the Duck River Basin in 1963-1964 showed that coliform concentrations increase with streamflow; highest values occur during periods of greatest runoff from agricultural lands. This pattern has been observed in other studies in the Southeast and probably occurs in the remainder of the Valley. The study also revealed that during periods of low flow, the primary source of coliform organisms was point discharges of domestic waste. To maintain acceptable bacteriological quality in streams and reservoirs to be used for recreation, there must be increased effort to control agricultural sources of coliform organisms.

Much is known about the short-term effects of pesticides at normal application levels, but less is known of the effects of long-term low-level exposure. A significant effect of some low-level pesticides is that which occurs as organisms at the lower end of the biological scale become contaminated with pesticides and are consumed by higher organisms. As this proceeds along the biological scale, it is possible for the pesticide content in some species to reach lethal concentrations under certain conditions.

Nutrients enter watercourses from four major sources: agricultural runoff, sewage treatment plant effluents, runoff from city streets, and waste from some industries. Excessive amounts of these nutrients may induce undesirable aquatic growths that are unsightly, produce odors, exert oxygen demand, and interfere with recreational uses. Aquatic weed growth has been heavy in Pickwick and Guntersville Reservoirs in northern Alabama and in the Holston River upstream from Cherokee Reservoir in northeastern Tennessee.

Nitrogen and phosphorus in water and sediment are believed to stimulate growth of aquatic weeds, but trace amounts of at least ten other mineral elements are known to be essential to sustain the growth. These essential nutrients normally are found in such quantities as to not limit aquatic growth, although there are other known factors that do limit growth, such as temperature, light penetration, and stream velocity. Just as no control levels have been established for pesticides, none have been established for nutrients.

Water Control Structures

The 32 major and 9 minor dams and reservoirs in the Tennessee Valley probably provide more effective control over streamflows than exists on any watershed of comparable size in the world. In general, these water control structures smooth out variations in streamflow—reducing peak rates of flood runoff and increasing streamflows during periods of dry weather—and are beneficial in controlling stream pollution. The reservoirs act as tremendous settling basins and thus reduce concentrations of suspended silt. Because of the size of the reservoirs, however, siltation reduces their combined storage capacity by only 1 percent every ten years. Bacteria from sewage sources are held in the pools for relatively long periods of time during which most of them die. Thus, reservoirs serve as effective barriers between upstream points of pollution and downstream points of water use.

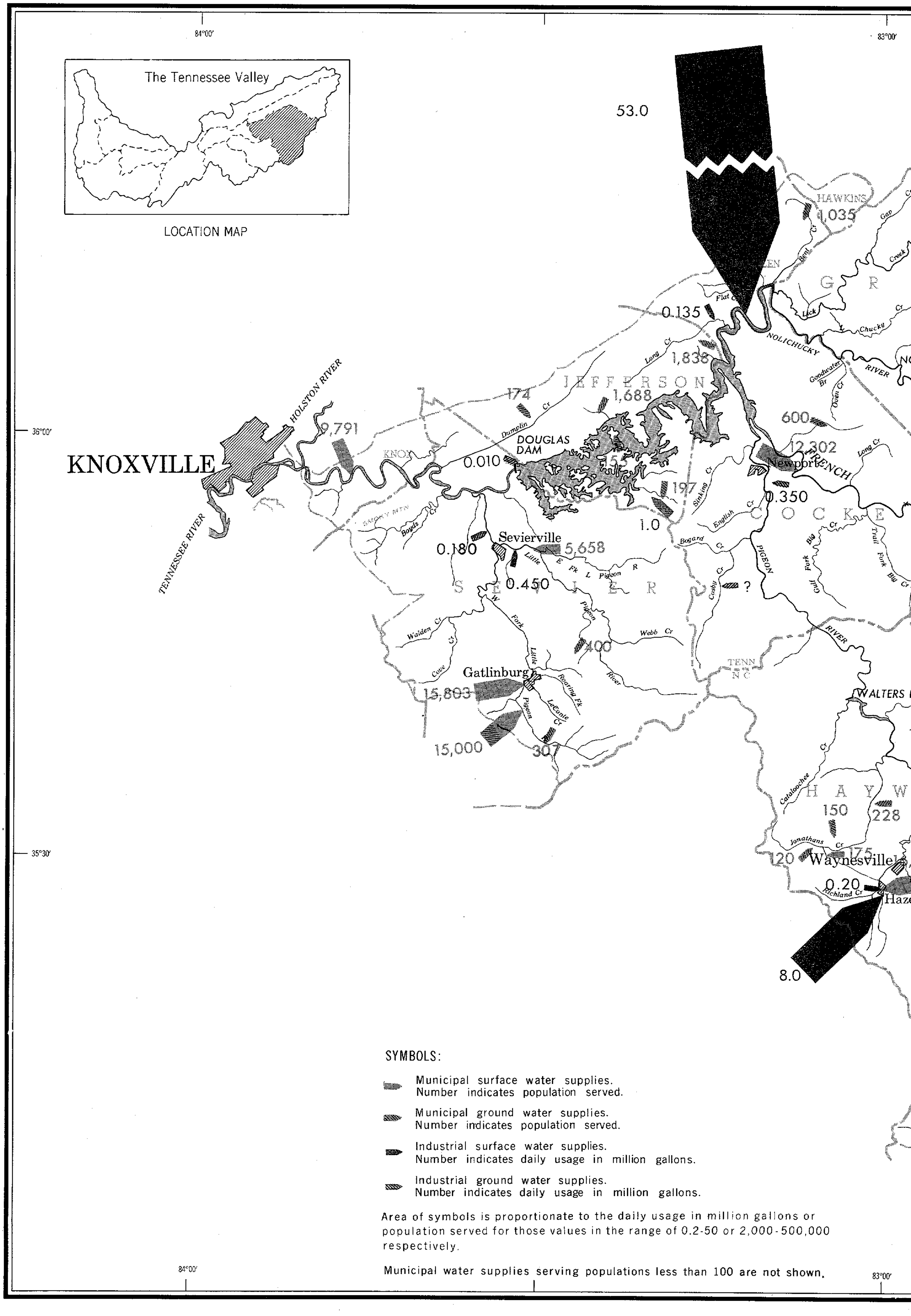
The use of dams and reservoirs for generating hydroelectric power results in intermittent releases of water, varying the flow downstream from hour to hour and usually from day to day. In some situations these variable flows may present problems of various kinds to downstream water users—including municipalities and industries that must rely on these streams to receive and carry off the effluent from their waste treatment facilities. Even after effective treatment, these liquid effluents frequently require considerable dilution before the receiving water is suitable for reuse. If controlled flow in the stream is very low for extended periods, water quality may be adversely affected unless at such times provision is made to limit discharges of wastes.

Dissolved oxygen is essential to aquatic life and is required in the natural, biochemical stabilization of organic wastes. Water released during the warmer months of the year from the deeper levels of some reservoirs that have low-level power intakes is low in, or devoid of, dissolved oxygen. Dissolved oxygen is depleted by the total respiratory demands of the aquatic community, and surface reaeration is prevented by thermal stratification. Water quality problems can and do occur downstream from these deep reservoirs, and upstream pollution may or may not be involved. Low concentrations of dissolved oxygen exist in waters discharged from some reservoirs in the Valley above which there is essentially no manmade pollution.

There are several potentially feasible methods of controlling levels of dissolved oxygen in releases from existing reservoirs, namely, (1) control of dissolved oxygen levels in the reservoir, (2) selective withdrawal of reservoir water, and (3) aeration of reservoir releases. Selection of the most feasible method is dependent in large measure upon the uses to be made of the water in the reservoir and downstream. The practical application of any of these methods requires extensive research, engineering design, and economic studies.

A preliminary study of the various methods for controlling levels of dissolved oxygen in reservoir releases indicates that turbine venting, some form of diffused air aeration, or injection of pure oxygen hold the most promise for solution of the problem. Large-scale tests and demonstrations of the more promising methods would be needed before plans could reasonably be made for operational applications. TVA is now studying alternative methods of reservoir operation, aeration of the reservoir and tailrace, and other potential methods of alleviating the problem.

FRENCH BROAD RIVER WATERSHED


84°00′
83°00′
36°00′
35°30′
The Tennessee Valley
LOCATION MAP
KNOXVILLE
HOLSTON RIVER
TENNESSEE RIVER
DOUGLAS DAM
Sevierville
Gatlinburg
Newport
Waynesville
JEFFERSON
KNOX
SEVIER
COCKE
HAWKINS
HAYWOOD
TENN
N C
NOLICHUCKY RIVER
FRENCH
PIGEON RIVER
WALTERS
53.0
1,035
0.135
1,838
1,688
174
9,791
0.010
600
12,302
197
0.350
1.0
0.180
5,658
0.450
?
400
15,803
15,000
307
150
228
120
175
0.20
8.0
SYMBOLS:
Municipal surface water supplies. Number indicates population served.
Municipal ground water supplies. Number indicates population served.
Industrial surface water supplies. Number indicates daily usage in million gallons.
Industrial ground water supplies. Number indicates daily usage in million gallons.
Area of symbols is proportionate to the daily usage in million gallons or population served for those values in the range of 0.2-50 or 2,000-500,000 respectively.
Municipal water supplies serving populations less than 100 are not shown.

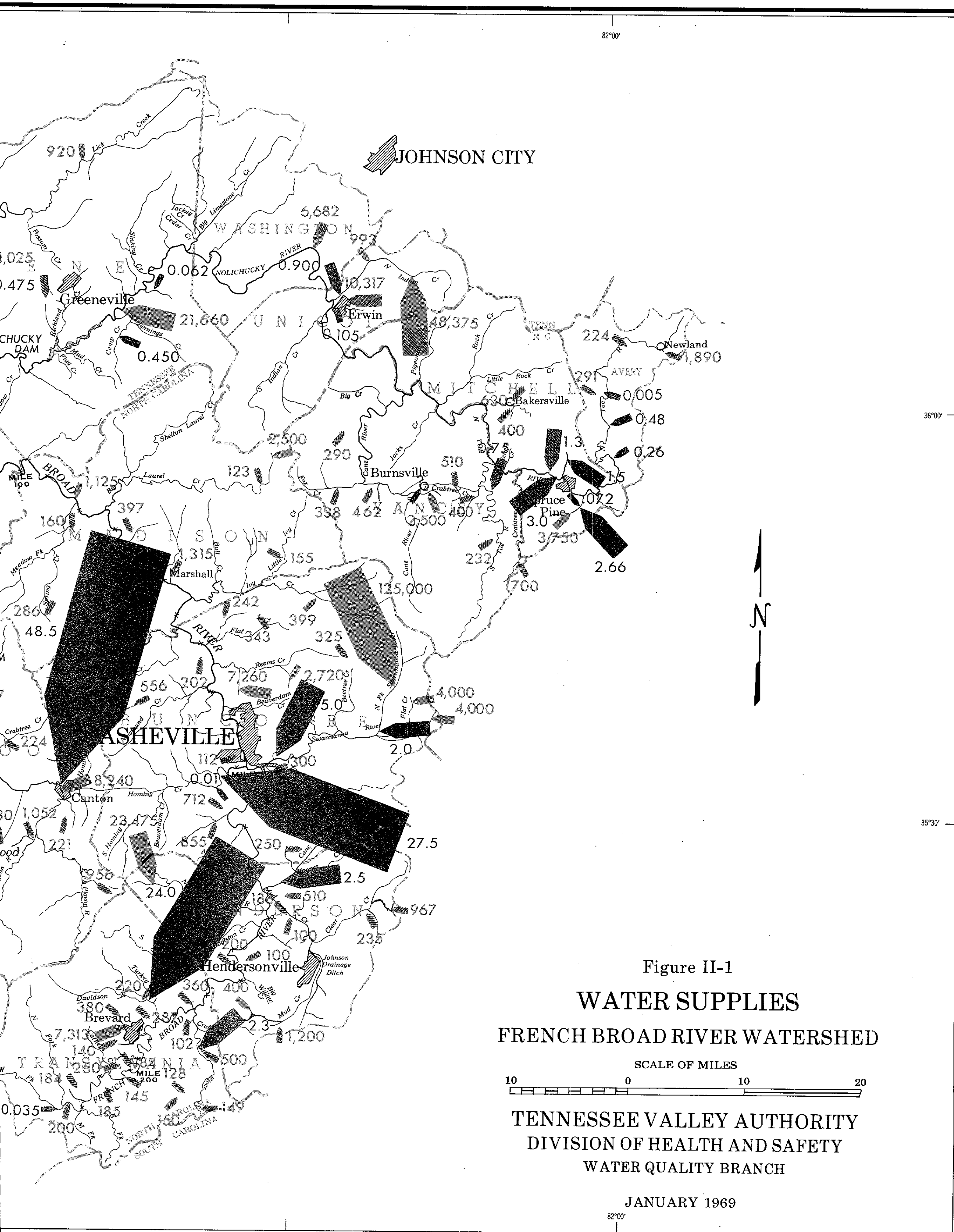


Figure II-1

WATER SUPPLIES

FRENCH BROAD RIVER WATERSHED

SCALE OF MILES

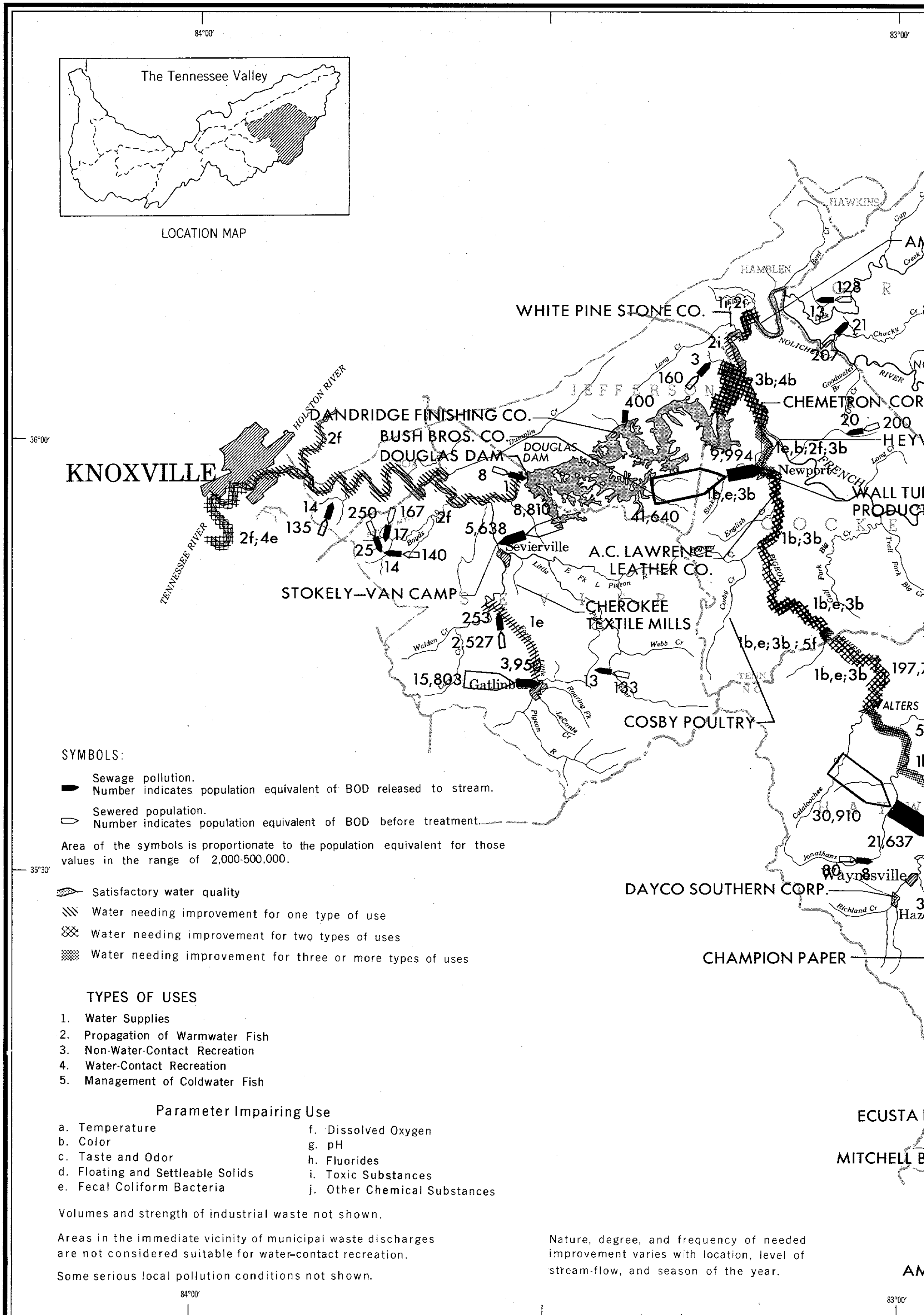
10 0 10 20

TENNESSEE VALLEY AUTHORITY

DIVISION OF HEALTH AND SAFETY

WATER QUALITY BRANCH

JANUARY 1969



The Tennessee Valley
LOCATION MAP
84°00'
83°00'
36°00'
35°30'
KNOXVILLE
TENNESSEE RIVER
HOLSTON RIVER
DANDRIDGE FINISHING CO.
BUSH BROS. CO.
DOUGLAS DAM
WHITE PINE STONE CO.
CHEMETRON COR
HAWKINS
HAMBLEN
JEFFERSON
NOLICHUCKY RIVER
Newport
FRENCH BROAD
A.C. LAWRENCE LEATHER CO.
CHEROKEE TEXTILE MILLS
STOKELY—VAN CAMP
Sevierville
Gatlinburg
COSBY POULTRY
PIGEON
Waynesville
DAYCO SOUTHERN CORP.
CHAMPION PAPER
ECUSTA
MITCHELL B
2f;4e
2f
8
8,810
41,640
9,994
5,638
3b;4b
1b,e;3b
1e,b;2f;3b
1b;3b
1b,e;3b;5f
1e
253
2,527
3,950
15,803
13
133
30,910
21,637
400
160
3
2i
128
13
21
207
20
200
14
135
250
167
17
25
140
SYMBOLS:
Sewage pollution. Number indicates population equivalent of BOD released to stream.
Sewered population. Number indicates population equivalent of BOD before treatment.
Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.
Satisfactory water quality
Water needing improvement for one type of use
Water needing improvement for two types of uses
Water needing improvement for three or more types of uses
TYPES OF USES
1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish
Parameter Impairing Use
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances
Volumes and strength of industrial waste not shown.
Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.
Some serious local pollution conditions not shown.
Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.

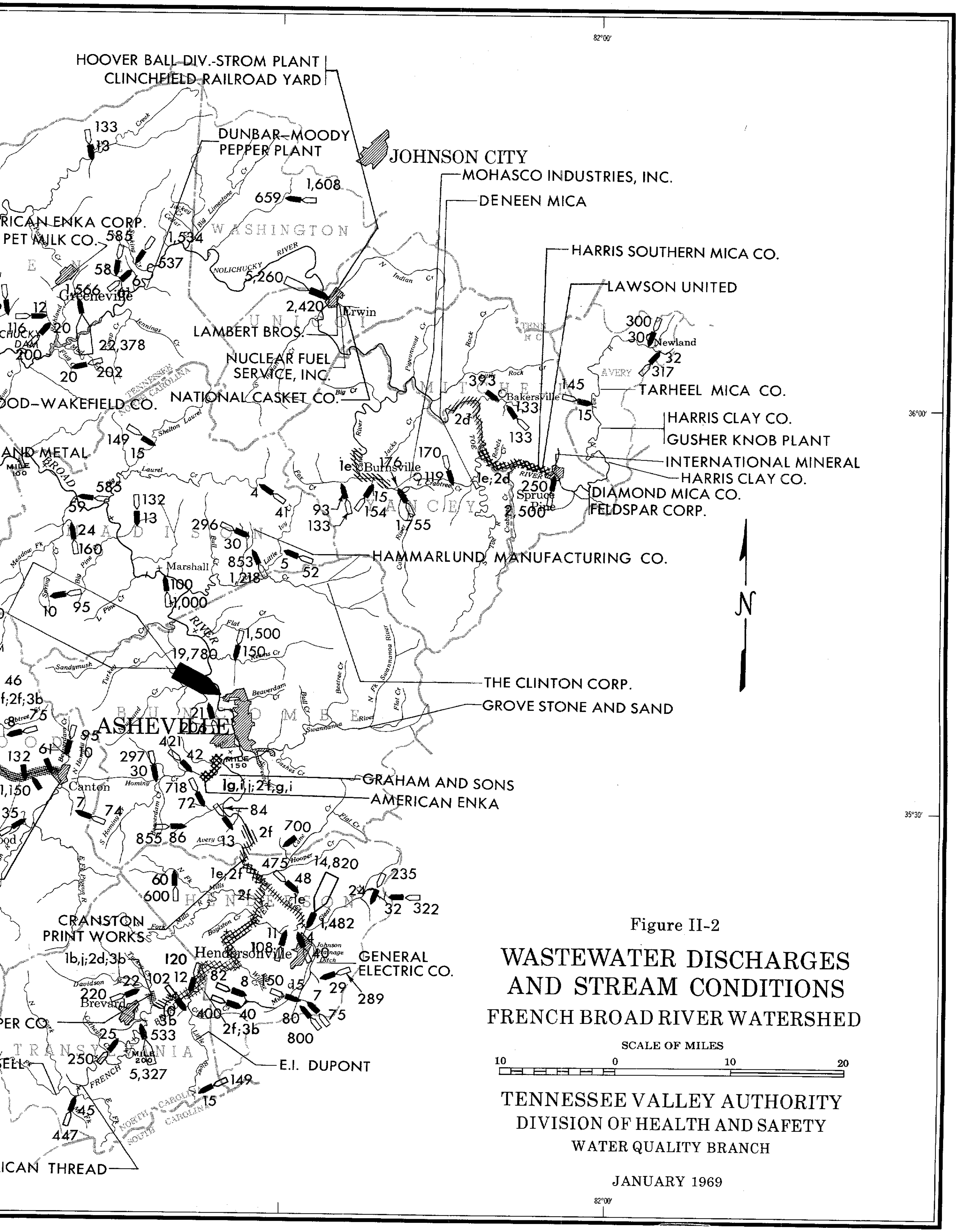


Figure II-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

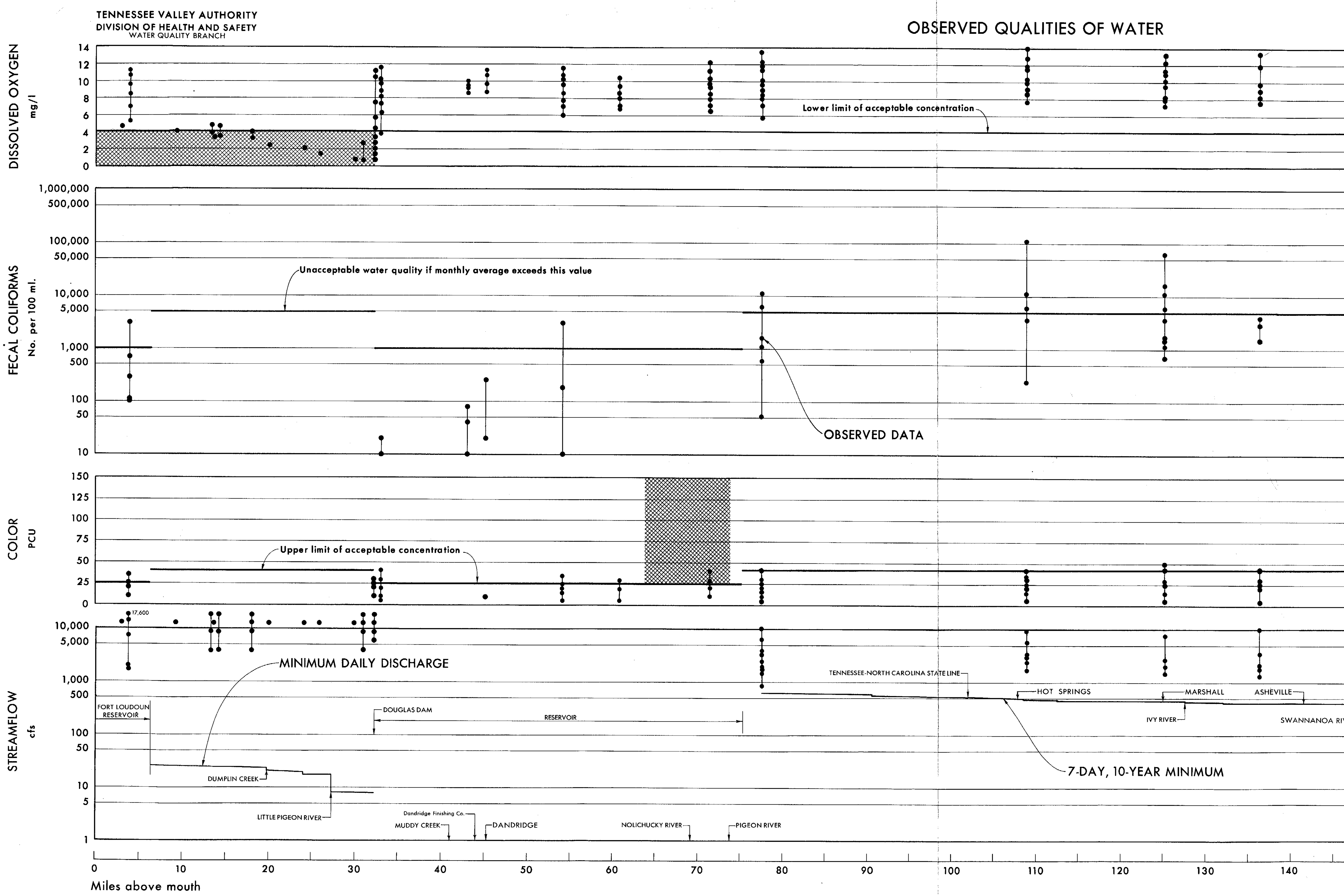
FRENCH BROAD RIVER WATERSHED

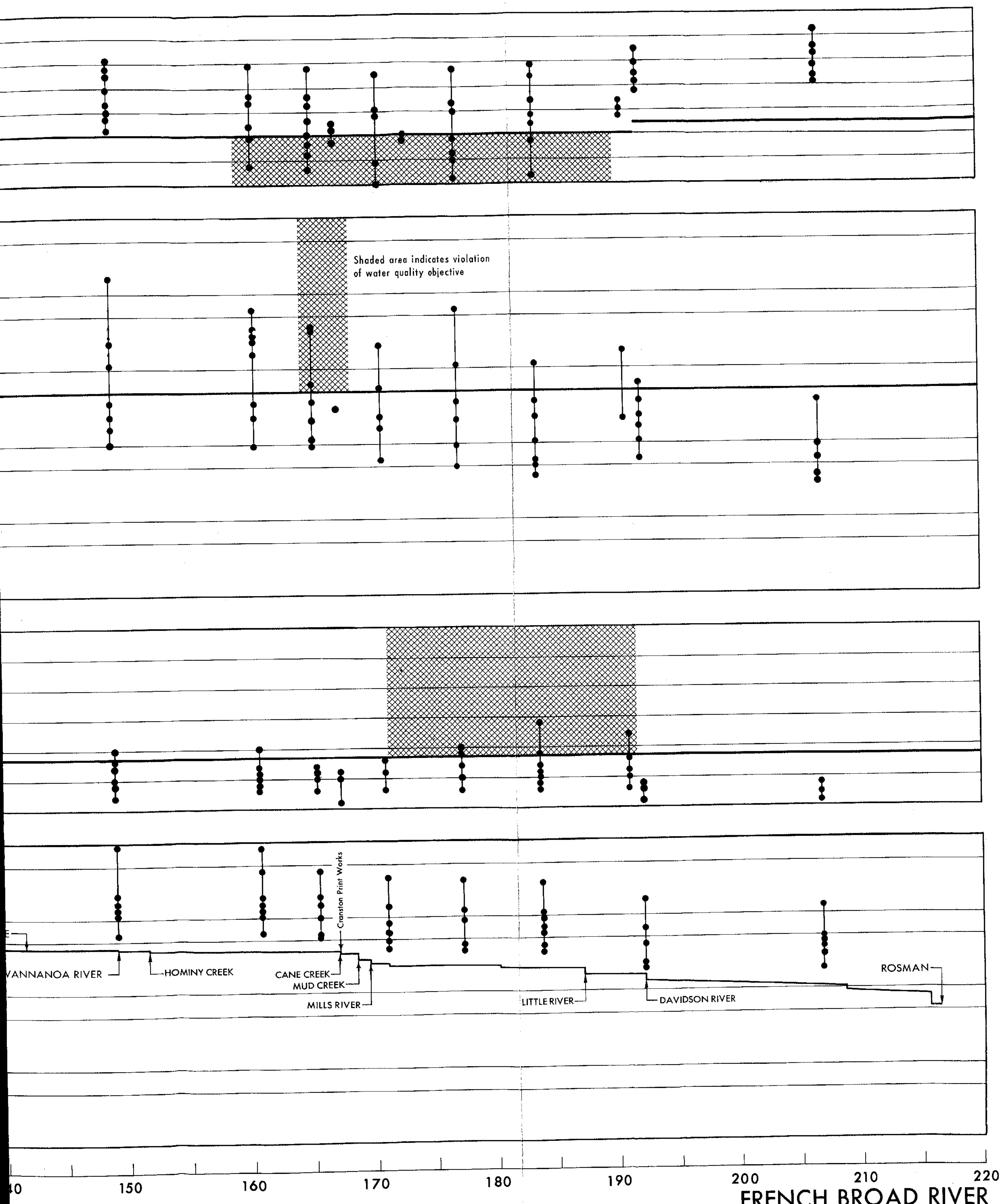
SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

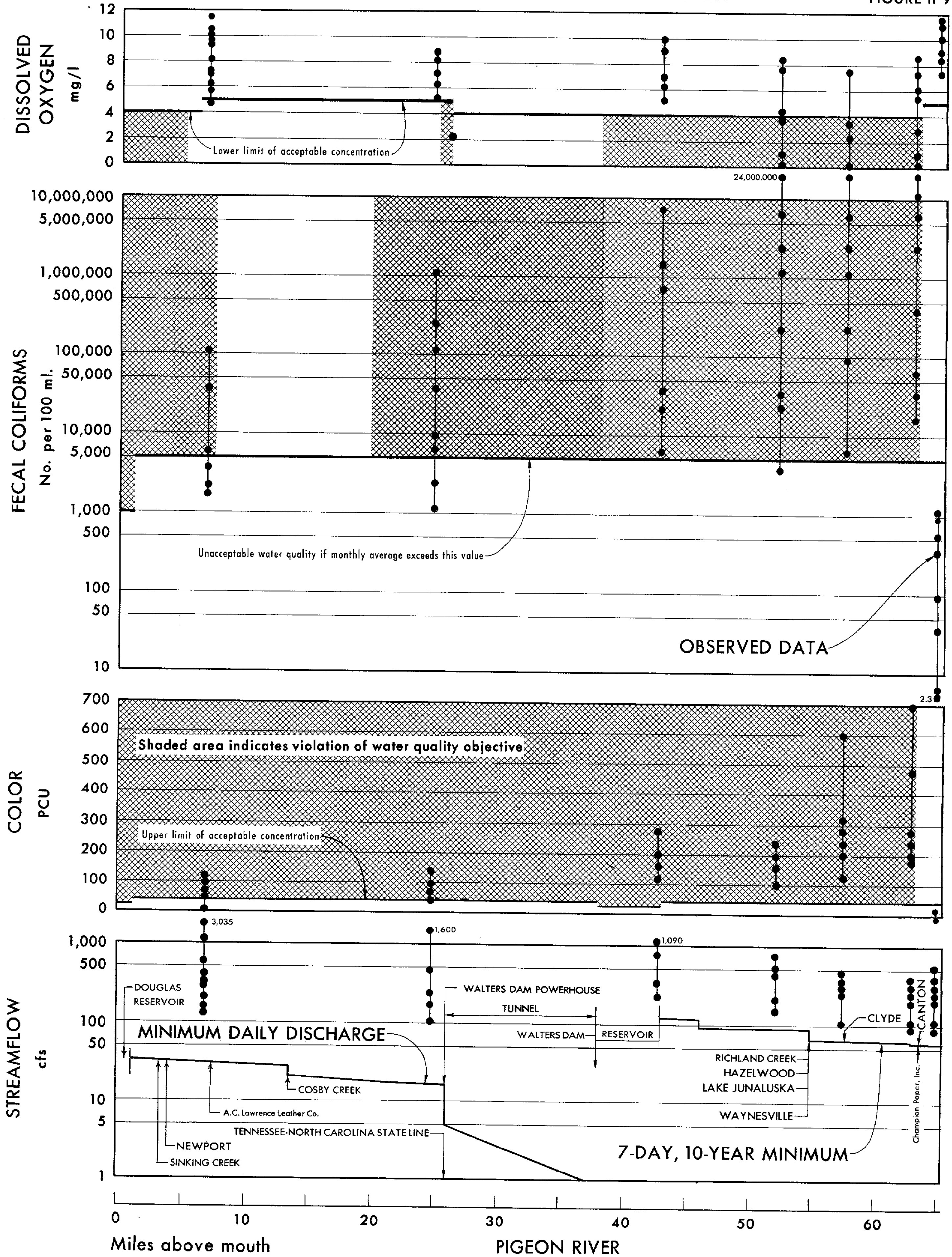

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
OBSERVED QUALITIES OF WATER
DISSOLVED OXYGEN
mg/l
Lower limit of acceptable concentration
FECAL COLIFORMS
No. per 100 ml.
Unacceptable water quality if monthly average exceeds this value
OBSERVED DATA
COLOR
PCU
Upper limit of acceptable concentration
STREAMFLOW
cfs
17,600
MINIMUM DAILY DISCHARGE
7-DAY, 10-YEAR MINIMUM
FORT LOUDOUN RESERVOIR
DUMPLIN CREEK
LITTLE PIGEON RIVER
DOUGLAS DAM
RESERVOIR
Dandridge Finishing Co.
MUDDY CREEK
DANDRIDGE
NOLICHUCKY RIVER
PIGEON RIVER
TENNESSEE-NORTH CAROLINA STATE LINE
HOT SPRINGS
MARSHALL
ASHEVILLE
IVY RIVER
SWANNANOA RI
Miles above mouth


Shaded area indicates violation of water quality objective
Cranston Print Works
SWANNANOA RIVER
HOMINY CREEK
CANE CREEK
MUD CREEK
MILLS RIVER
LITTLE RIVER
DAVIDSON RIVER
ROSMAN
150
160
170
180
190
200
210
220
FRENCH BROAD RIVER

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUALITIES OF WATER

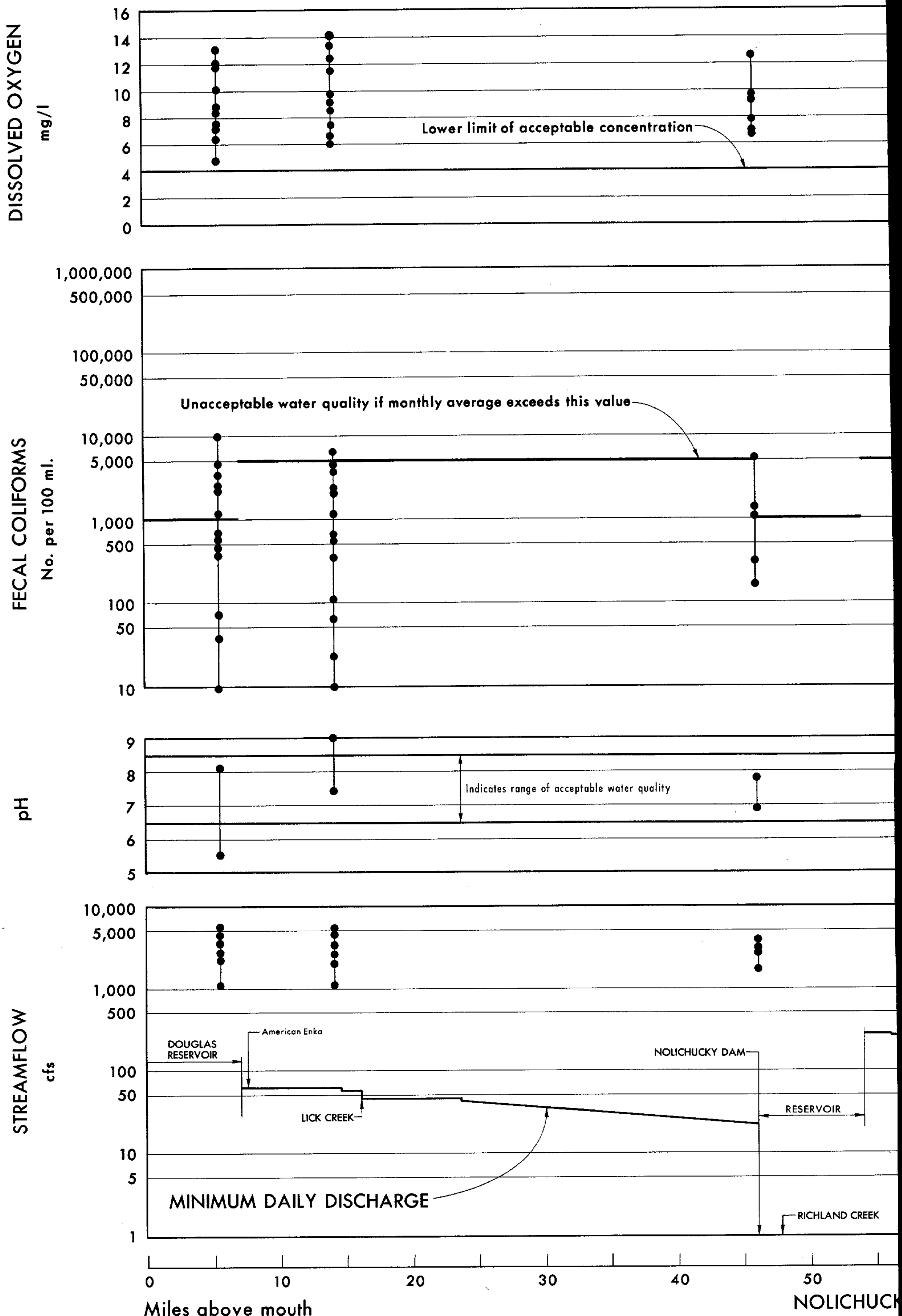
FIGURE II-9



TRIBUTARIES OF FRENCH BROAD RIVER

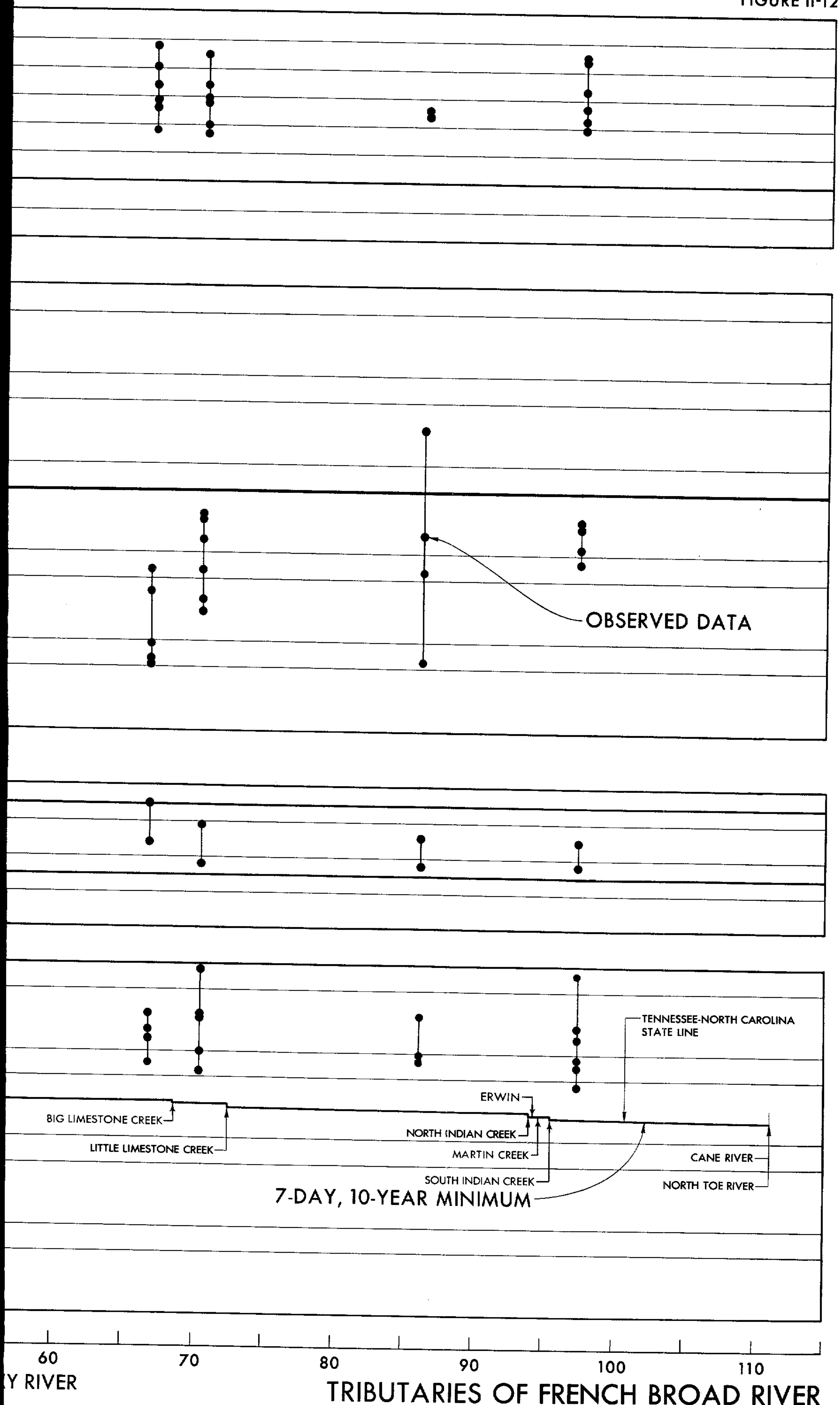
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QU

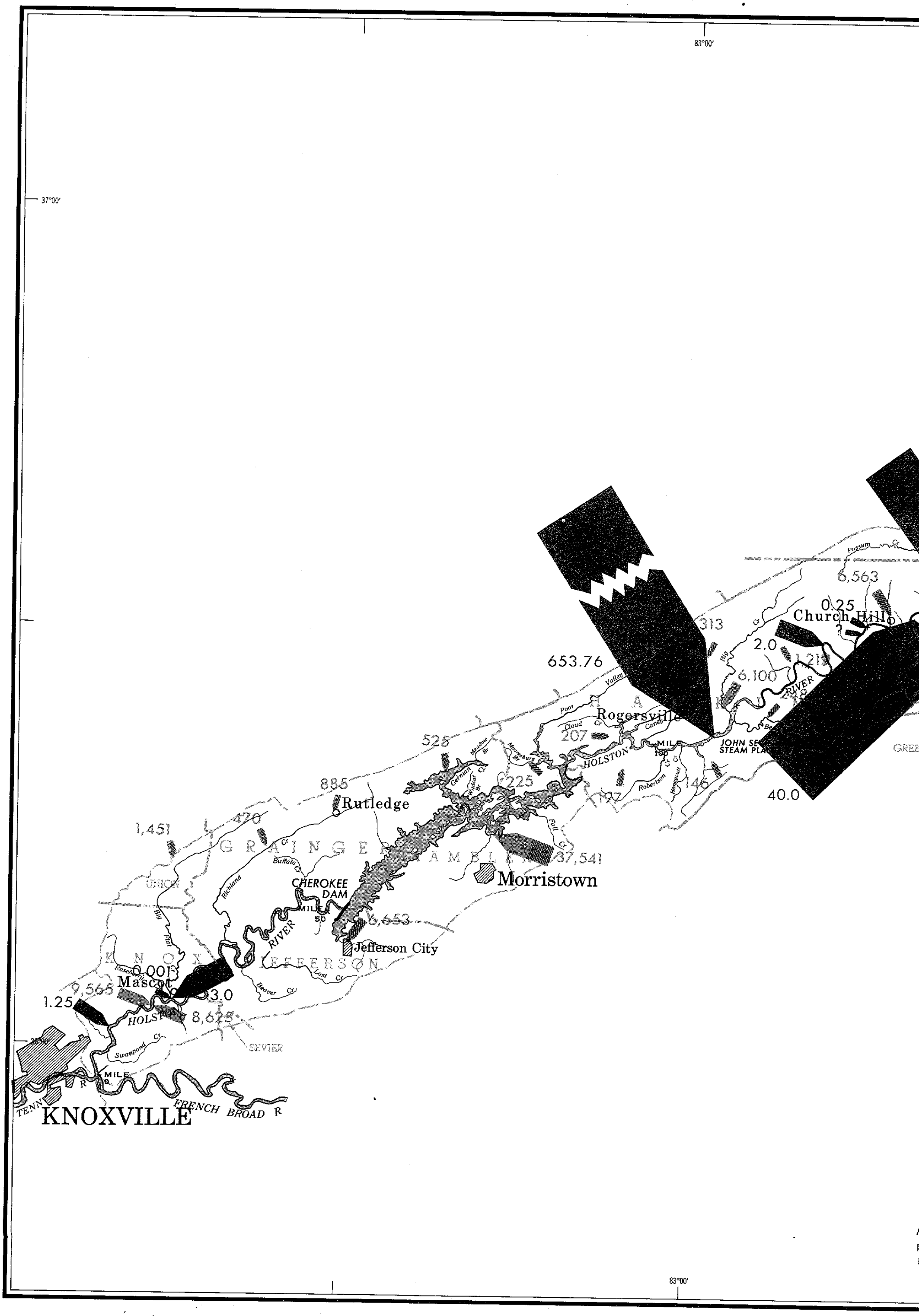


ALITIES OF WATER

FIGURE II-12



HOLSTON RIVER WATERSHED


83°00′
37°00′
6,563
0.25
Church Hill
313
2.0
1,218
653.76
6,100
RIVER
Rogersville
Poor
Valley
Cloud Cr
207
Caney
HOLSTON
MILE 100
JOHN SE
STEAM PLA
Robertson Cr
Honeycutt
146
40.0
GREE
528
Meadow Br
German
Wildcat Br
Mooresburg Br
225
197
885
Rutledge
1,451
470
G R A I N G E R
H A M B L E N
Buffalo Cr
Richland
Fall Cr
37,541
Morristown
UNION
CHEROKEE DAM
MILE 50
RIVER
6,653
Big
Flat
Jefferson City
K N O X
JEFFERSON
Lost Cr
Beaver Cr
0.001
Mascot
9,565
1.25
3.0
HOLSTON
8,625
Swanpond Cr
SEVIER
MILE
TENN
KNOXVILLE
FRENCH BROAD R
83°00′

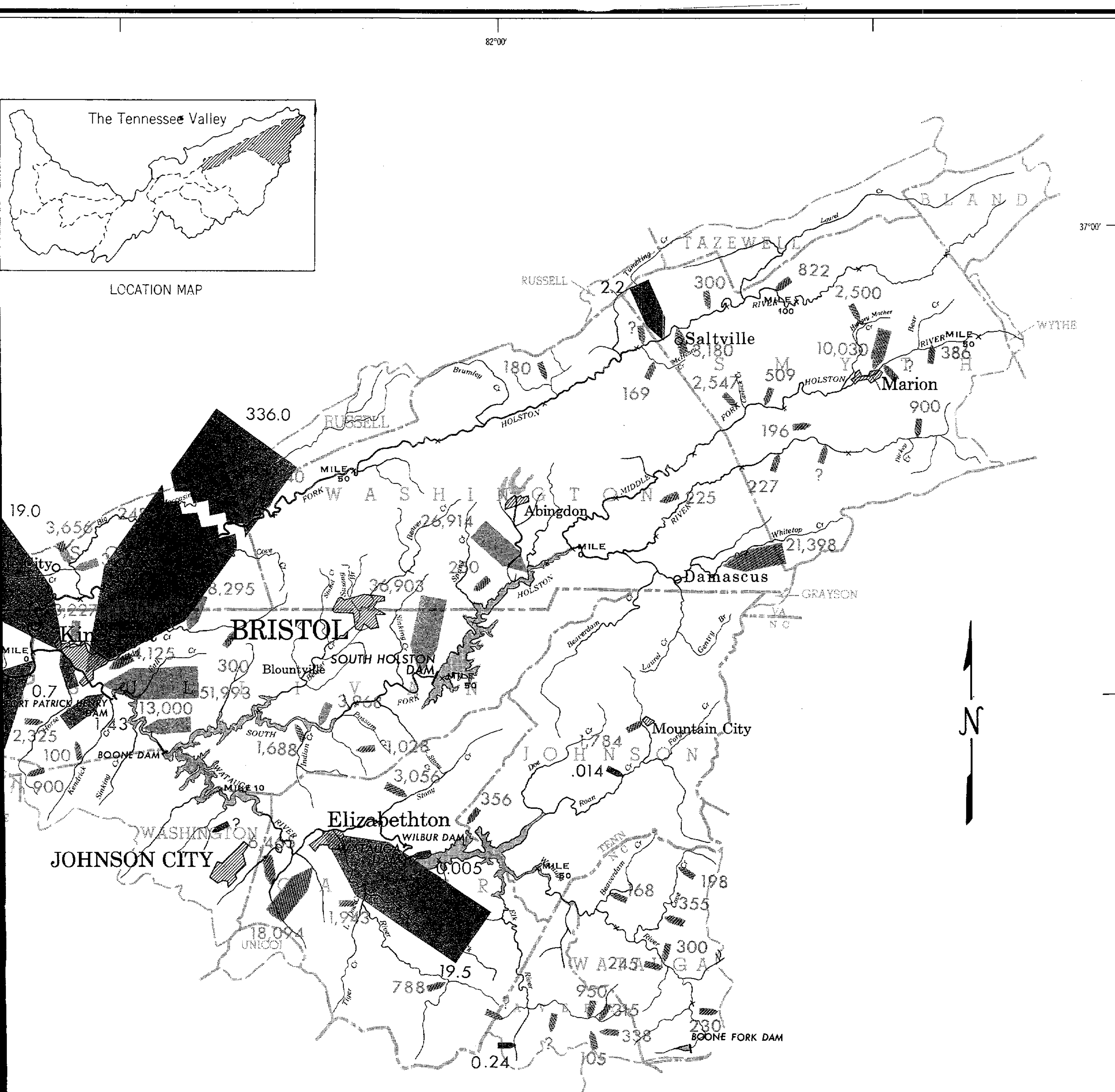


Figure III-1

WATER SUPPLIES

HOLSTON RIVER WATERSHED

SCALE OF MILES

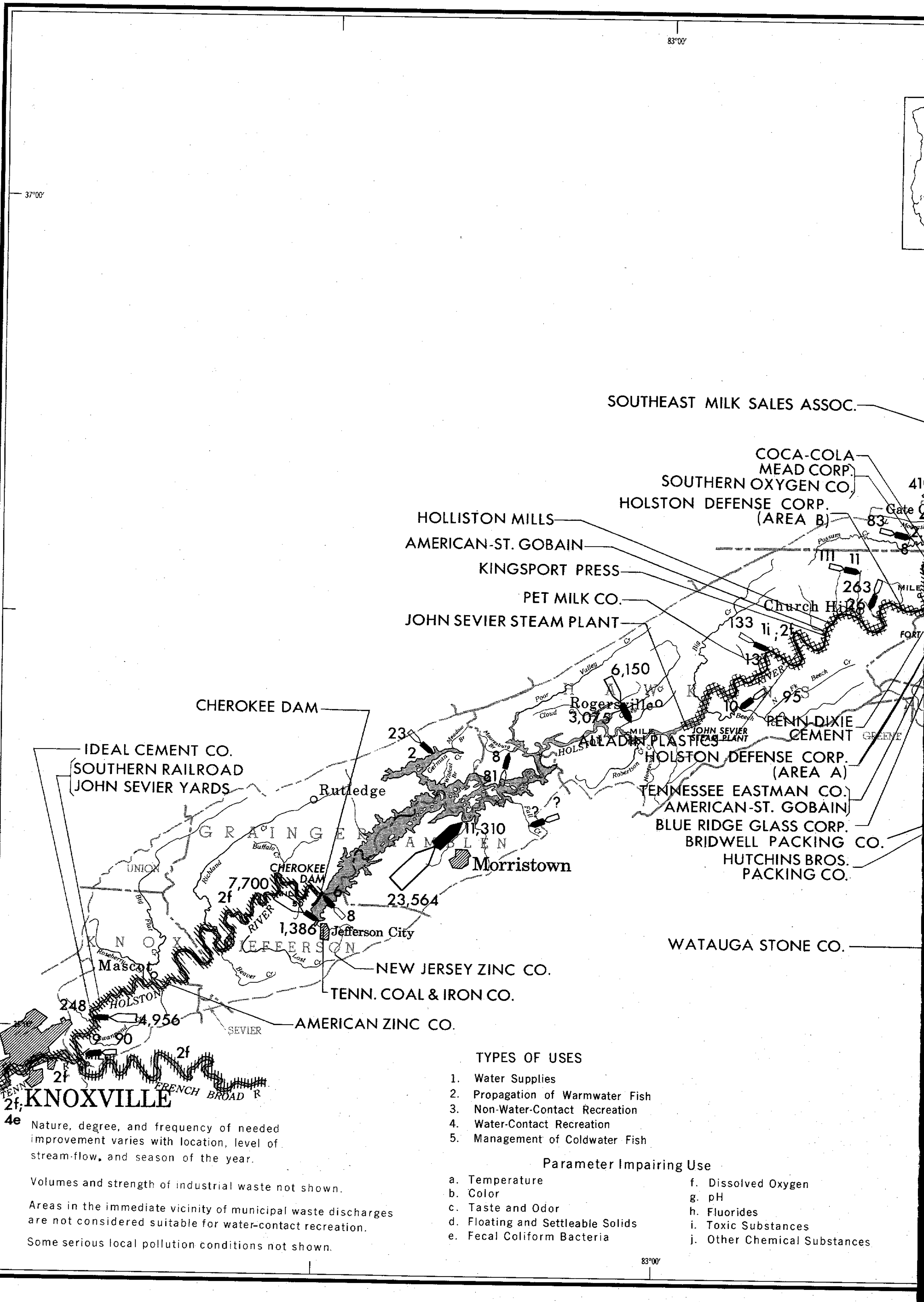
10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969

SYMBOLS:

- Municipal surface water supplies. Number indicates population served.
- Municipal ground water supplies. Number indicates population served.
- Industrial surface water supplies. Number indicates daily usage in million gallons.
- Industrial ground water supplies. Number indicates daily usage in million gallons.

Area of symbols is proportionate to the daily usage in million gallons or population served for those values in the range of 0.2-50 or 2,000-500,000 respectively Municipal water supplies serving populations less than 100 are not shown.



83°00′
37°00′
SOUTHEAST MILK SALES ASSOC.
COCA-COLA
MEAD CORP.
SOUTHERN OXYGEN CO.
HOLSTON DEFENSE CORP. (AREA B)
HOLLISTON MILLS
AMERICAN-ST. GOBAIN
KINGSPORT PRESS
PET MILK CO.
JOHN SEVIER STEAM PLANT
CHEROKEE DAM
IDEAL CEMENT CO.
SOUTHERN RAILROAD
JOHN SEVIER YARDS
PENN-DIXIE CEMENT
ALLADIN PLASTICS
HOLSTON DEFENSE CORP. (AREA A)
TENNESSEE EASTMAN CO.
AMERICAN-ST. GOBAIN
BLUE RIDGE GLASS CORP.
BRIDWELL PACKING CO.
HUTCHINS BROS. PACKING CO.
WATAUGA STONE CO.
NEW JERSEY ZINC CO.
TENN. COAL & IRON CO.
AMERICAN ZINC CO.
Church Hill
Rogersville
Rutledge
Morristown
Jefferson City
Mascot
KNOXVILLE
GRAINGER
HAMBLEN
HAWKINS
KNOX
JEFFERSON
UNION
SEVIER
GREENE
HOLSTON
RIVER
FRENCH BROAD R
CHEROKEE DAM
JOHN SEVIER STEAM PLANT
6,150
3,075
11,310
23,564
7,700
1,386
4,956
248
90
133
263
83
2f
2f;
4e
TYPES OF USES
1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish
Parameter Impairing Use
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances
Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.
Volumes and strength of industrial waste not shown.
Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.
Some serious local pollution conditions not shown.

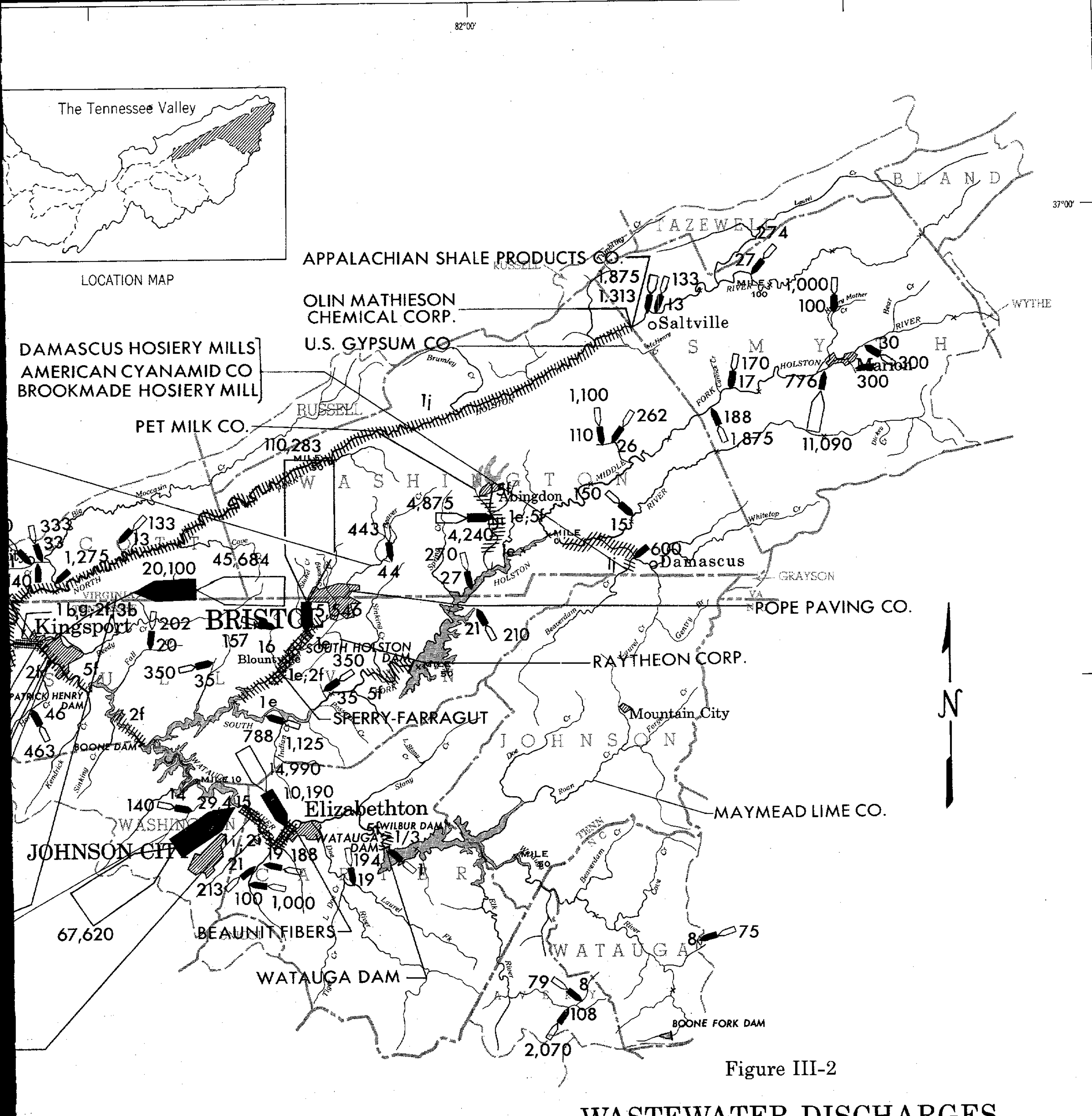


Figure III-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

HOLSTON RIVER WATERSHED

SCALE OF MILES

10 0 10 20

SYMBOLS:

- Sewage pollution. Number indicates population equivalent of BOD released to stream.
- Sewered population. Number indicates population equivalent of BOD before treatment.

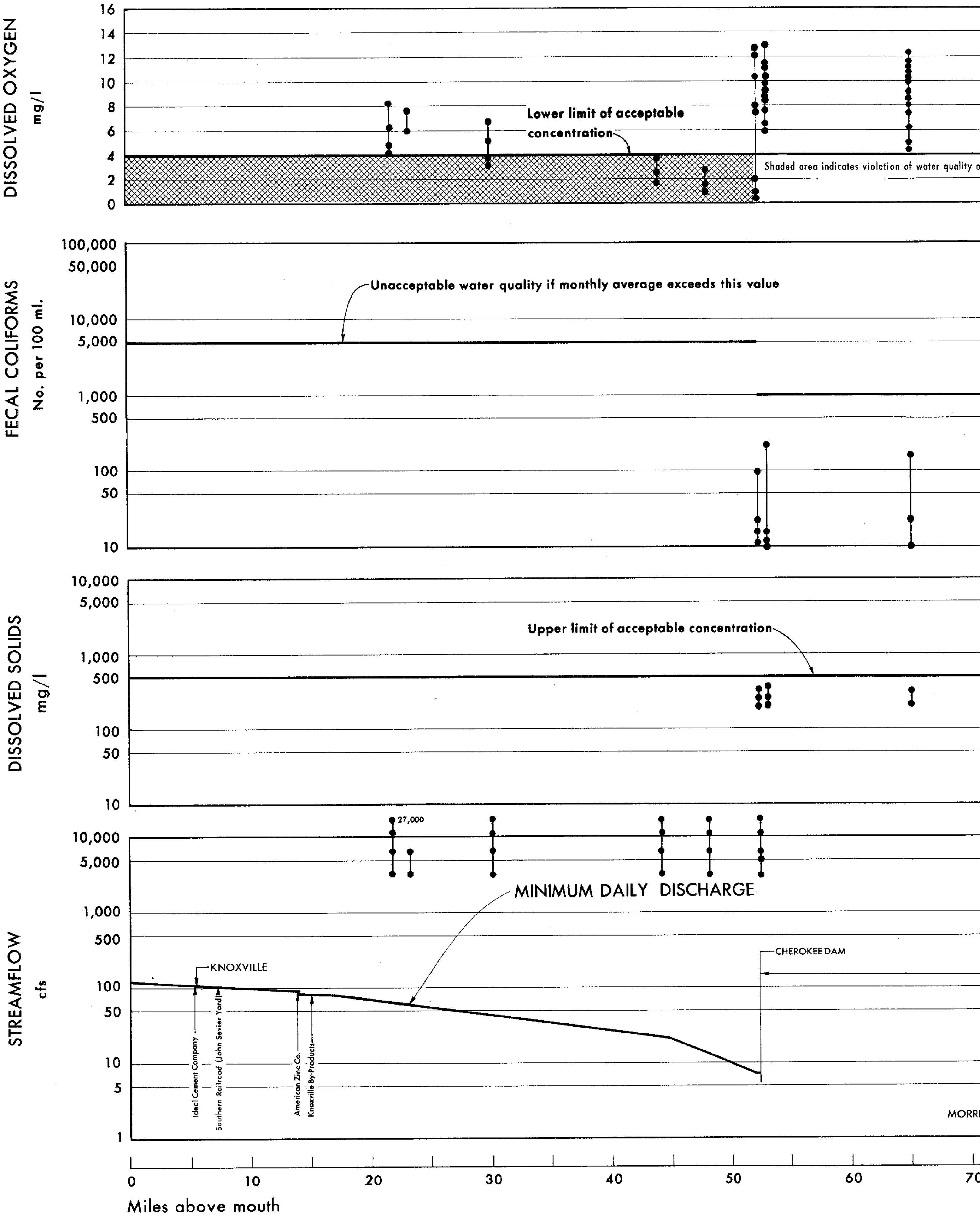
Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.

- Satisfactory water quality
- Water needing improvement for one type of use
- Water needing improvement for two types of uses
- Water needing improvement for three or more types of uses

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969

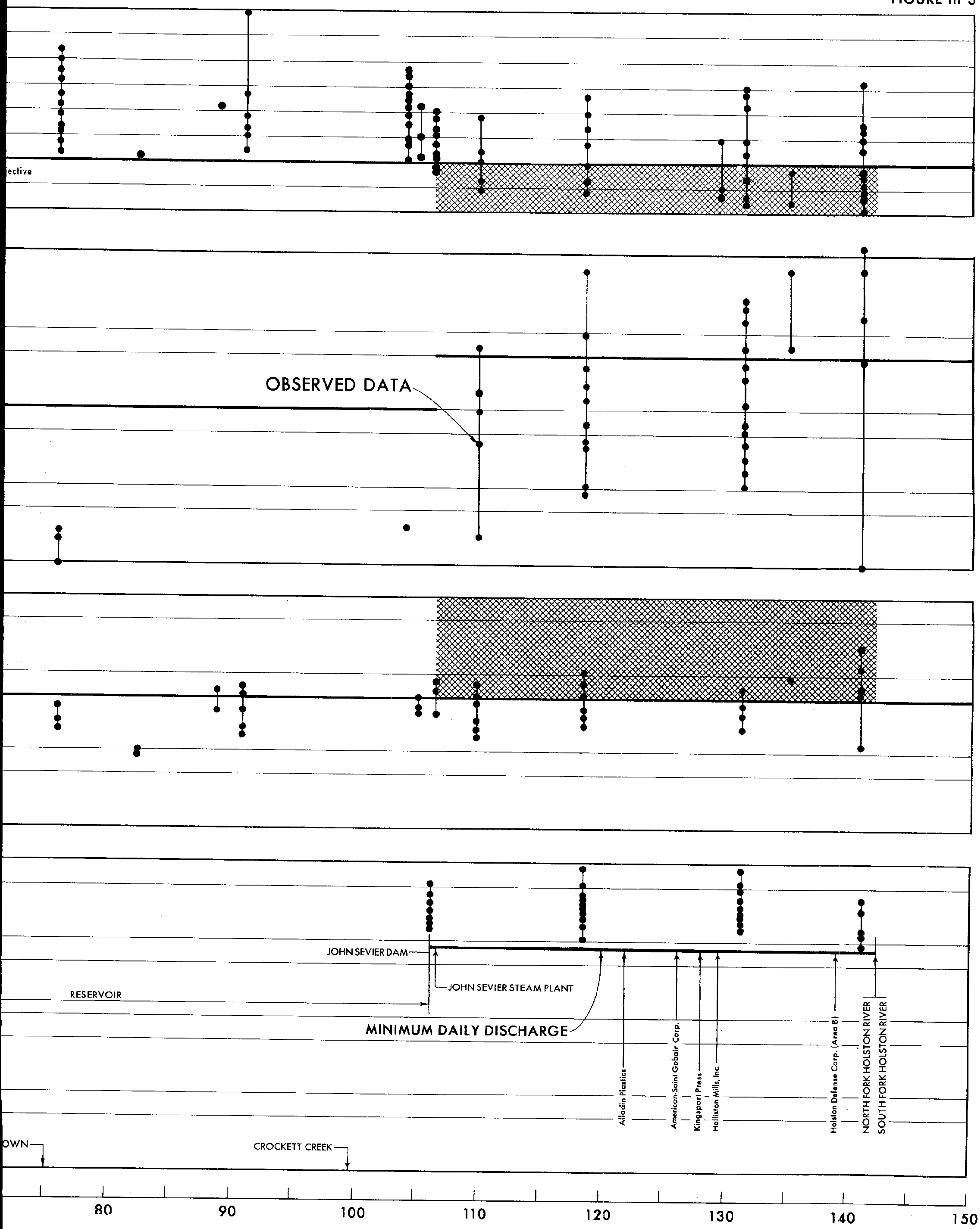
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUALI



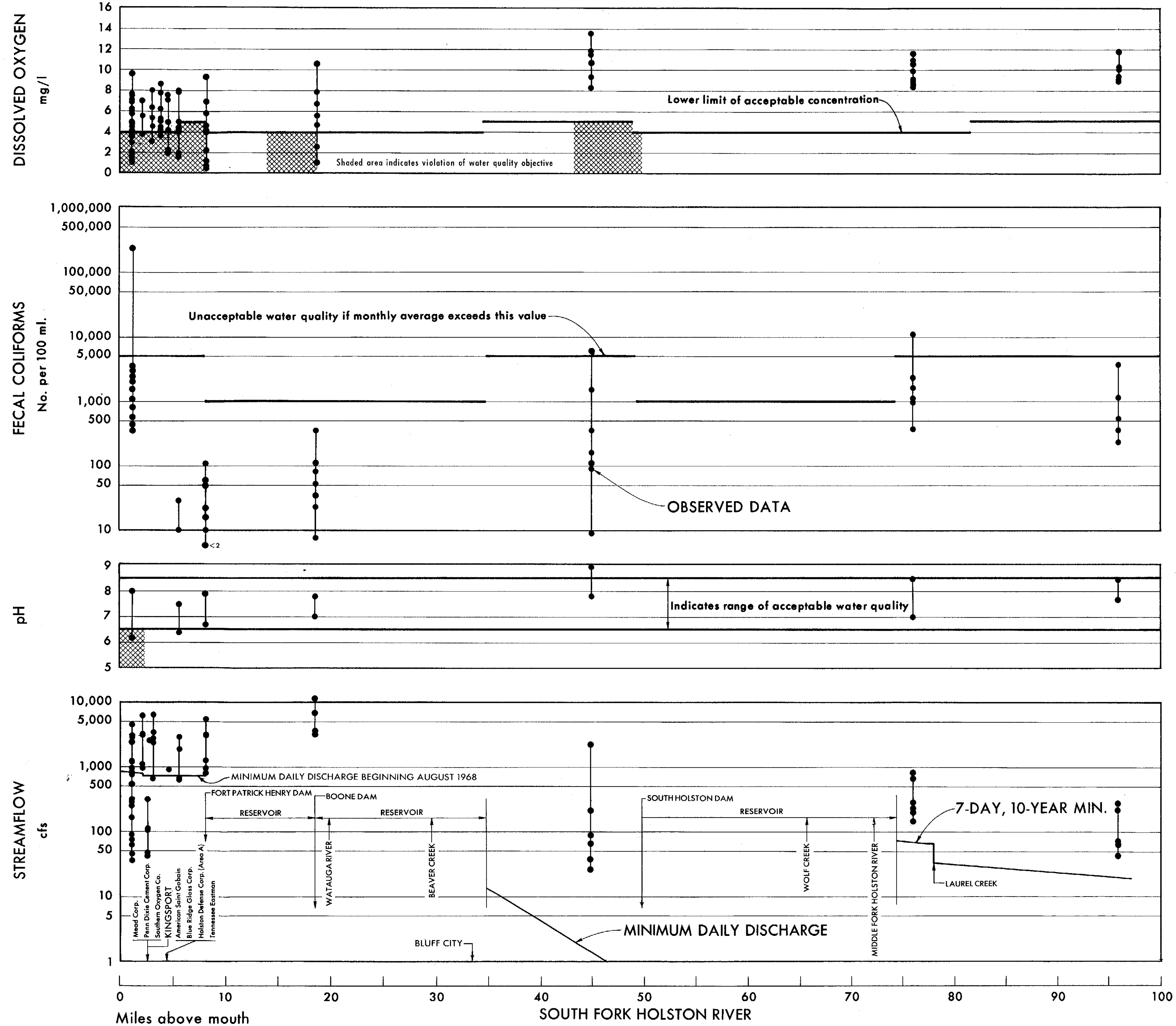
TIES OF WATER

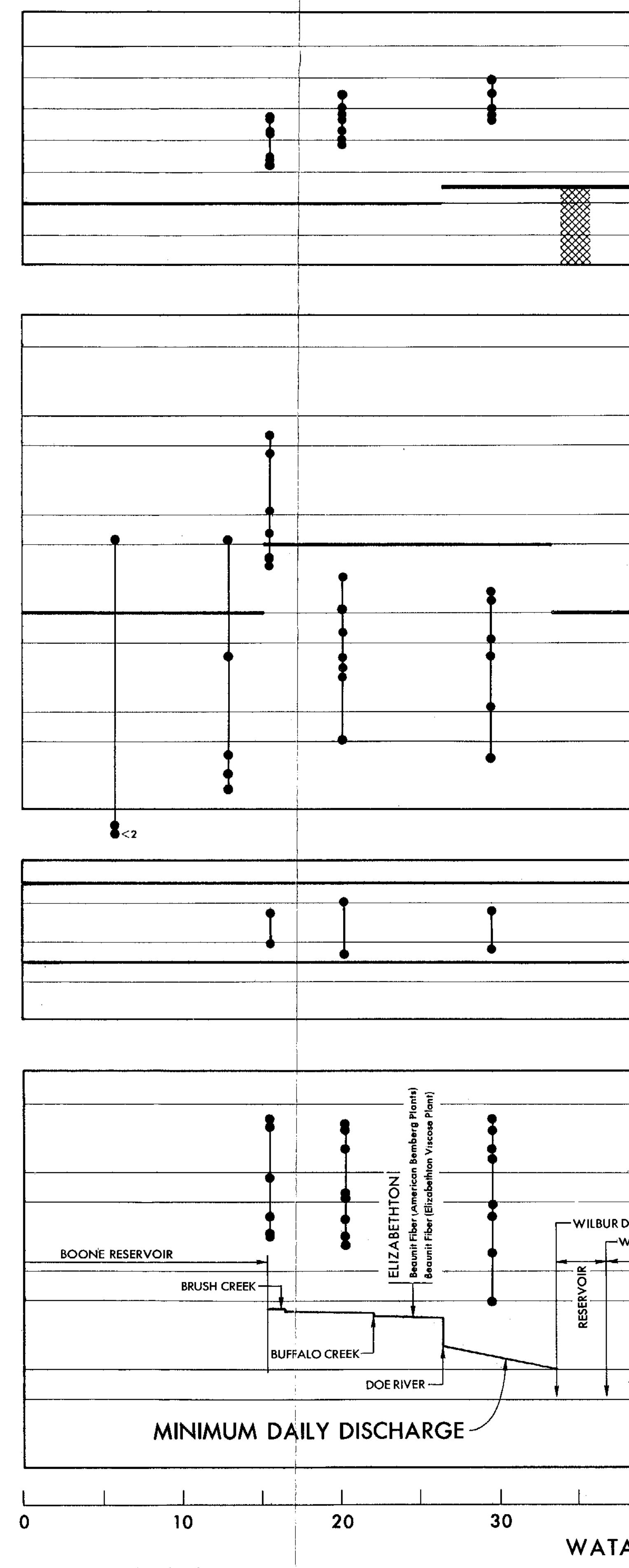
FIGURE III-3



TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

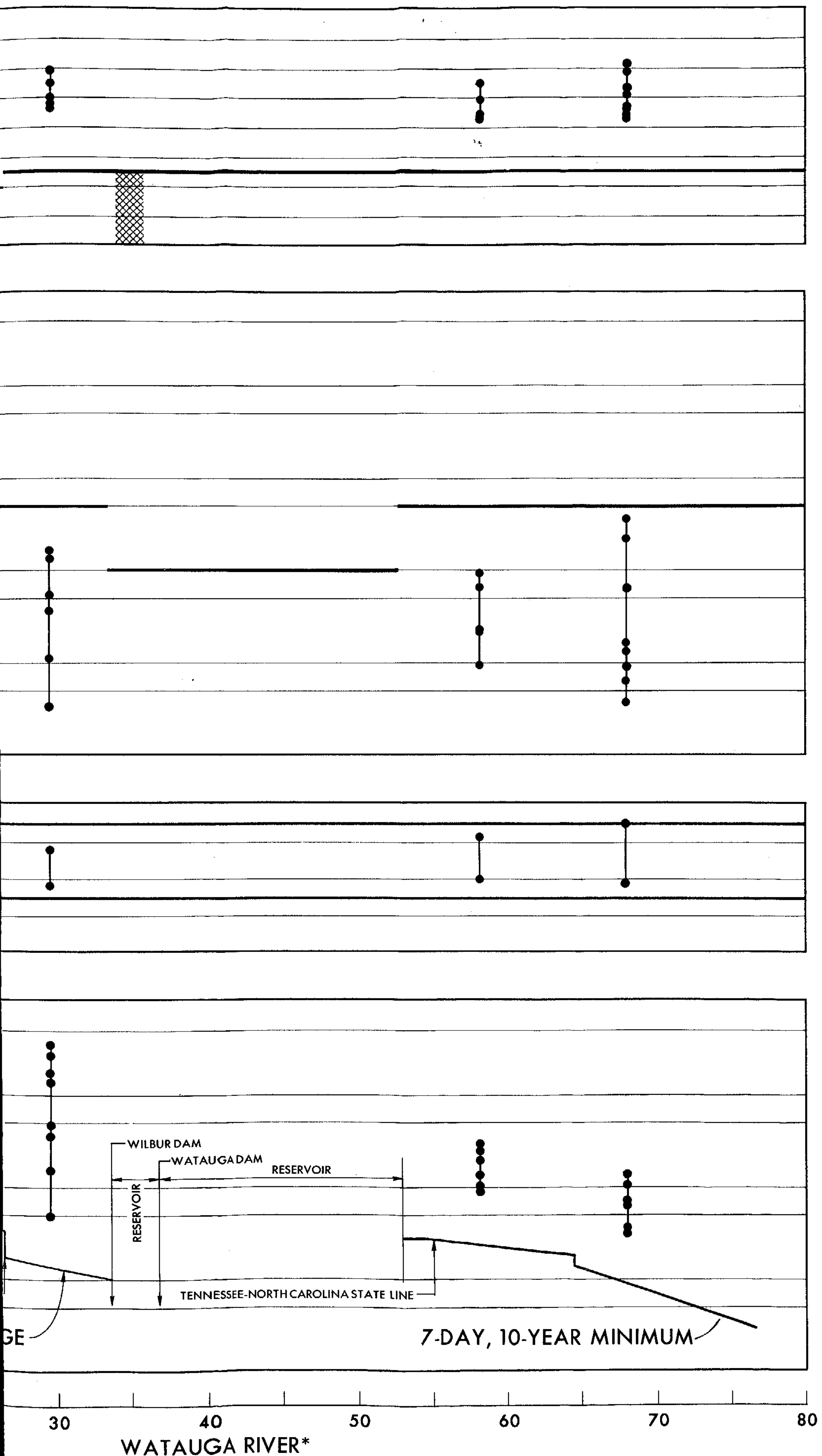
OBSERVED QUALITIES OF WATER





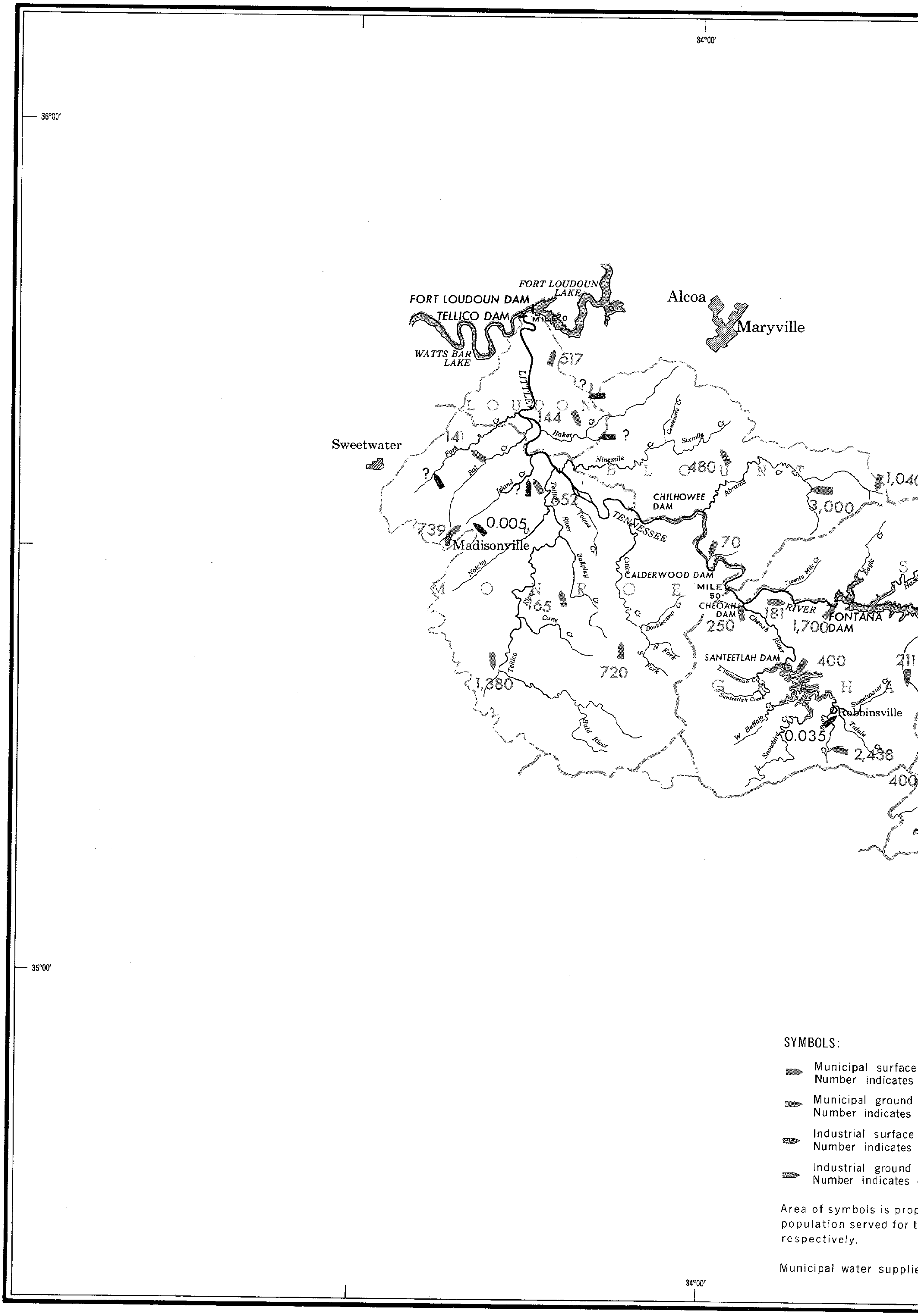
*Tributary of South Fork Holston River

FIGURE III-5

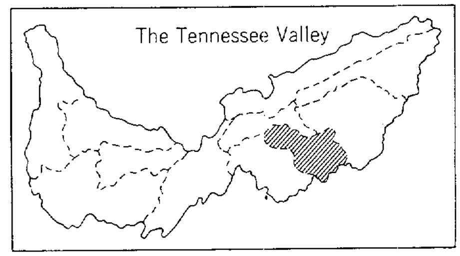


TRIBUTARIES OF HOLSTON RIVER

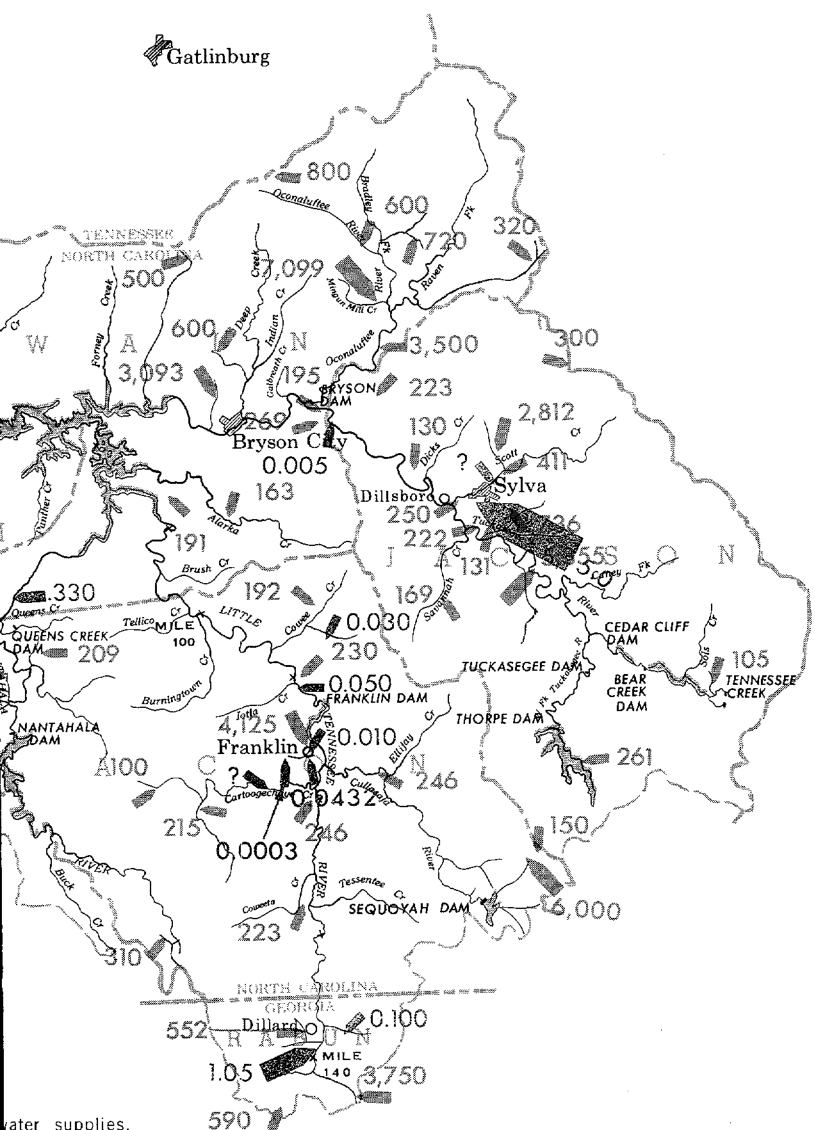
LITTLE TENNESSEE RIVER WATERSHED



84°00'
36°00'
35°00'
FORT LOUDOUN LAKE
FORT LOUDOUN DAM
TELLICO DAM
MILE 0
WATTS BAR LAKE
Alcoa
Maryville
Sweetwater
Madisonville
Robbinsville
LOUDON
BLOUNT
MONROE
GRAHAM
LITTLE TENNESSEE RIVER
CHILHOWEE DAM
CALDERWOOD DAM
MILE 50
CHEOAH DAM
SANTEETLAH DAM
FONTANA DAM
517
144
141
480
1,040
3,000
652
0.005
739
70
165
181
250
1,700
400
720
1,380
0.035
2,438
SYMBOLS:
Municipal surface
Number indicates
Municipal ground
Number indicates
Industrial surface
Number indicates
Industrial ground
Number indicates
Area of symbols is prop
population served for t
respectively.
Municipal water supplie



LOCATION MAP



ater supplies.
pulation served.

ater supplies.
pulation served.

ater supplies.
ily usage in million gallons.

ater supplies.
ily usage in million gallons.

rtionate to the daily usage in million gallons or
se values in the range of 0.2-50 or 2,000-500,000

serving populations less than 100 are not shown.

Figure IV-1

WATER SUPPLIES

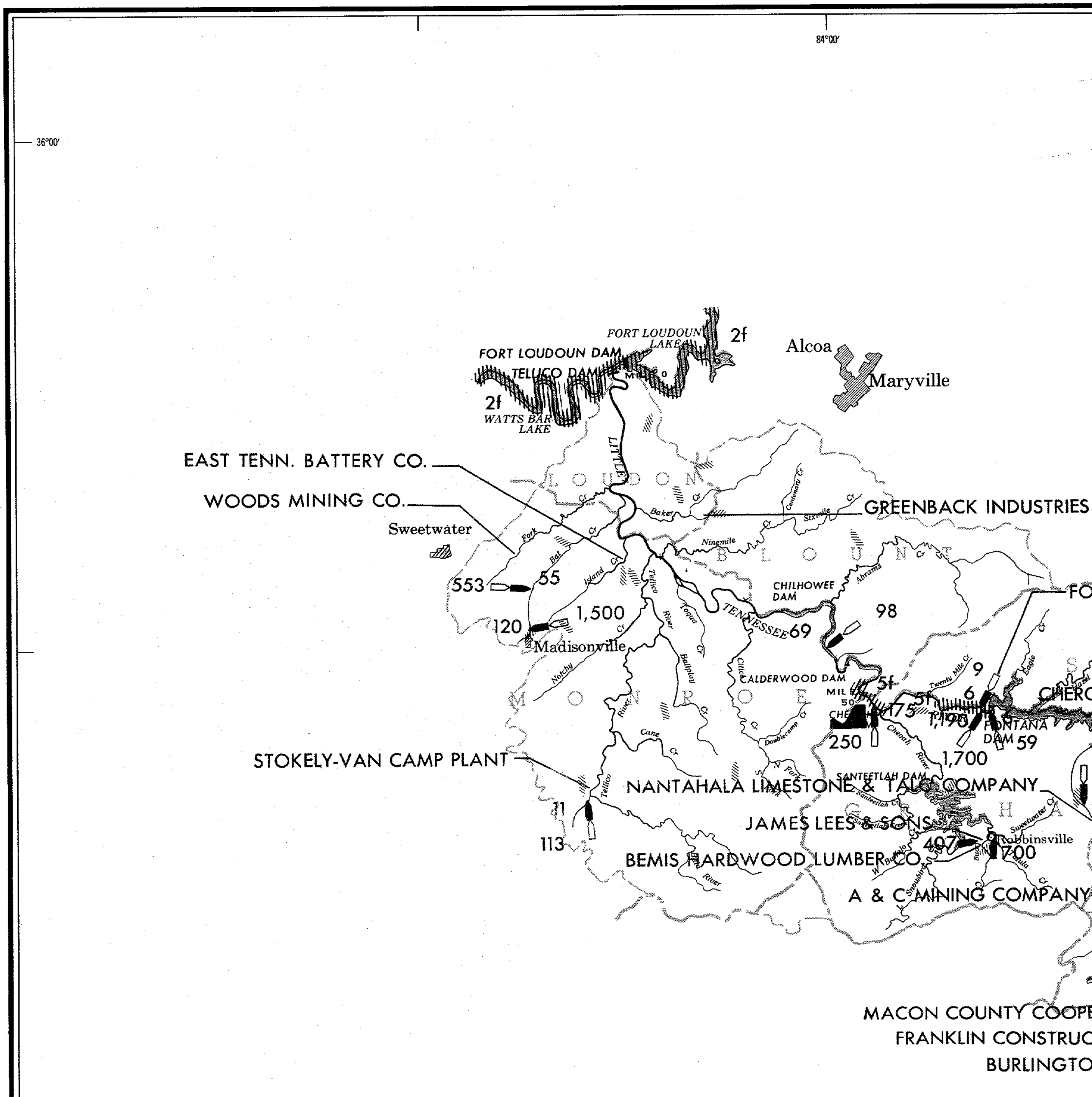
LITTLE TENNESSEE RIVER WATERSHED

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969



TYPES OF USES

1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish

Parameter Impairing Use

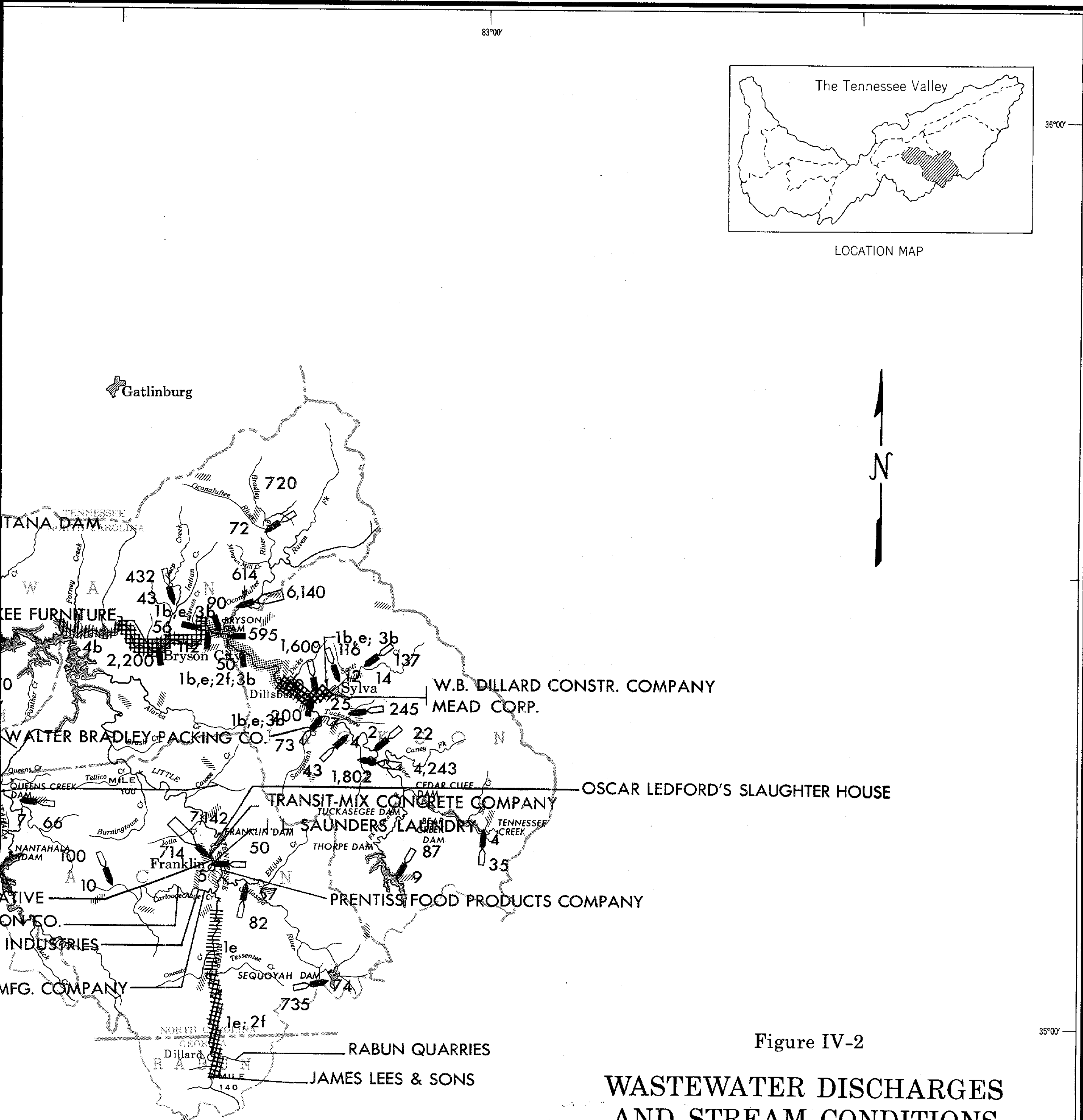
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances

Volumes and strength of industrial waste not shown.

Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.

Some serious local pollution conditions not shown

Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.



SYMBOLS:

- Sewage pollution. Number indicates population equivalent of BOD released to stream.
- Sewered population. Number indicates population equivalent of BOD before treatment.

Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000

- Satisfactory water quality
- Water needing improvement for one type of use
- Water needing improvement for two types of uses
- Water needing improvement for three or more types of uses

Figure IV-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

LITTLE TENNESSEE RIVER WATERSHED

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY

DIVISION OF HEALTH AND SAFETY

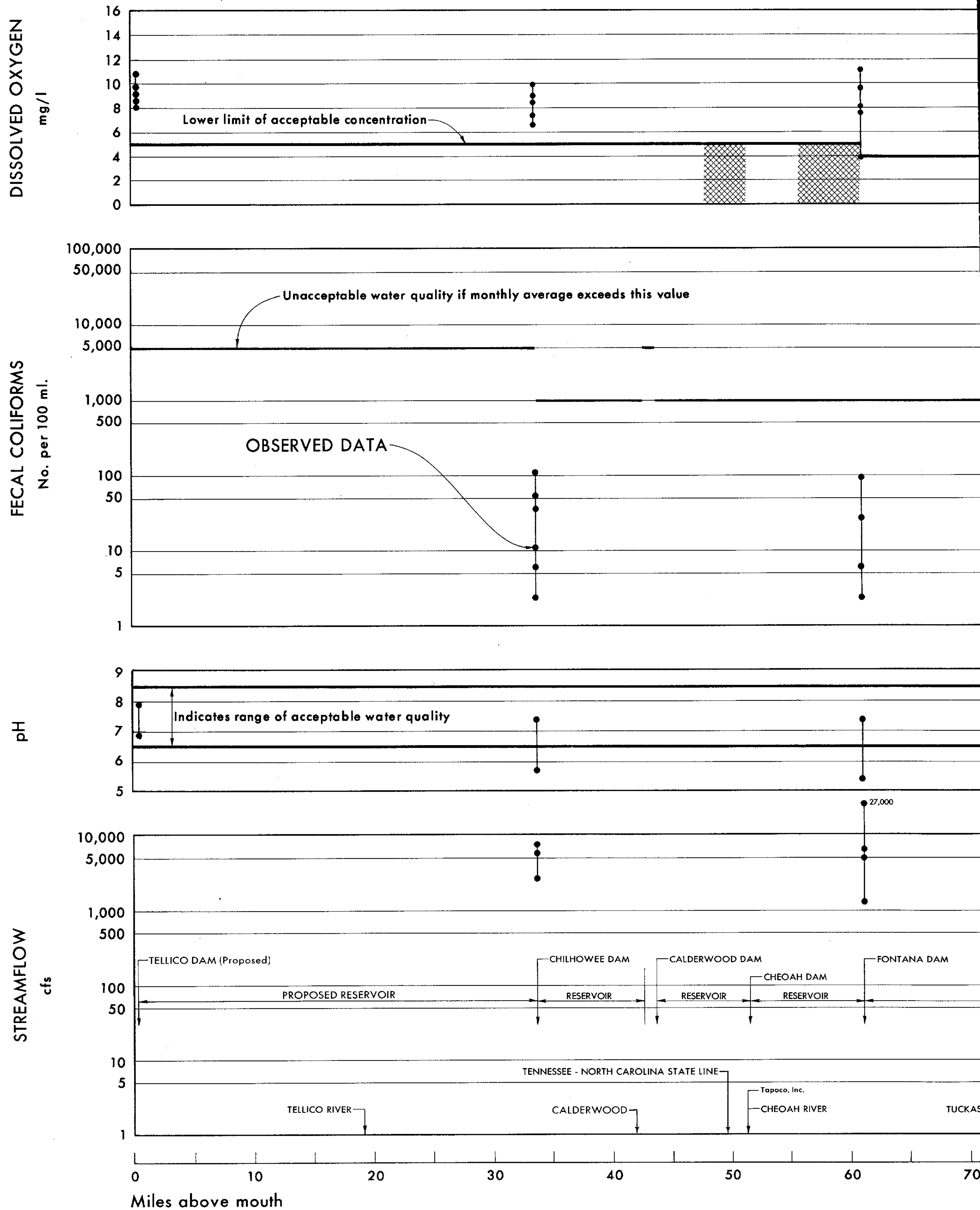
WATER QUALITY BRANCH

JANUARY 1969

83°00′

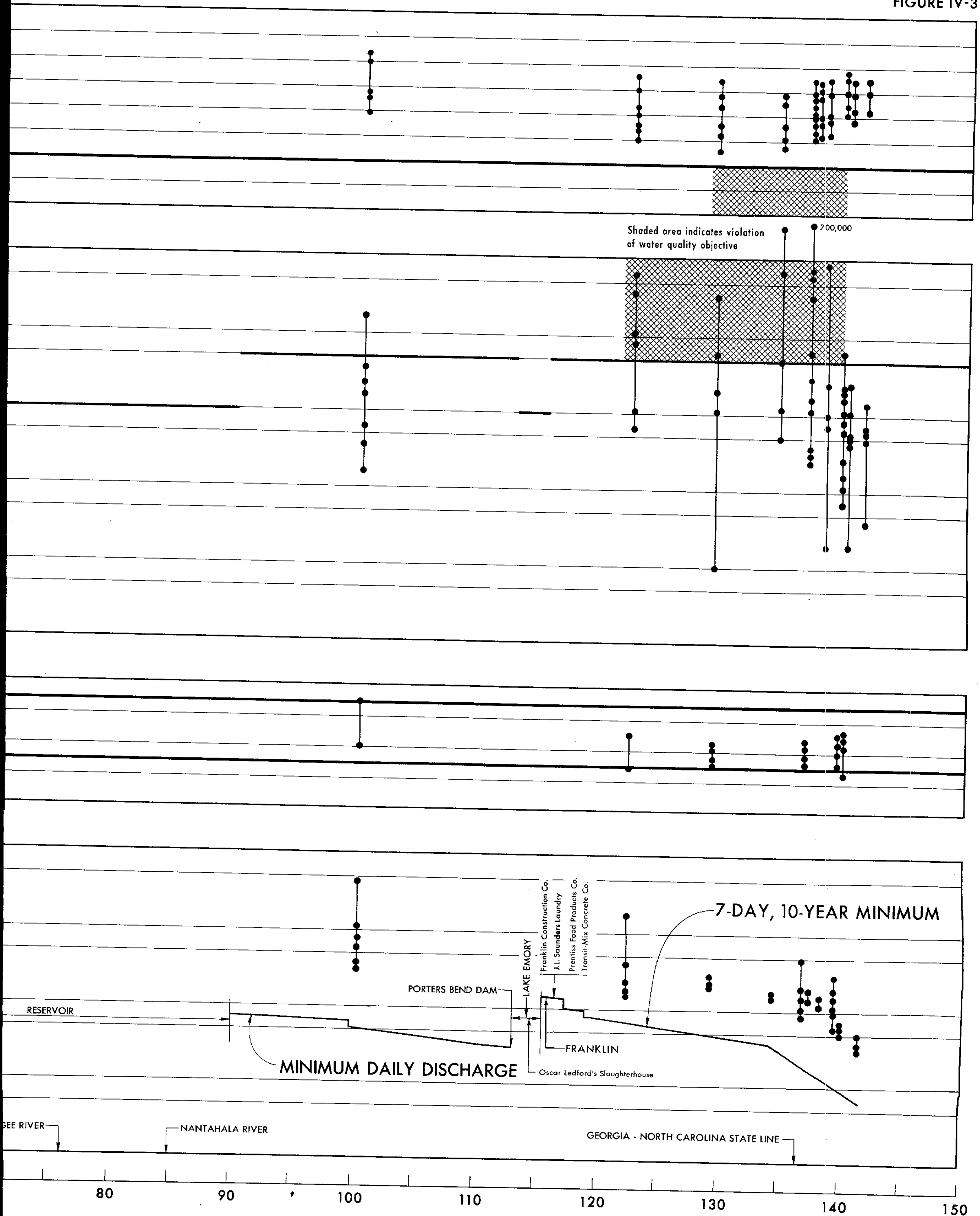
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUAL



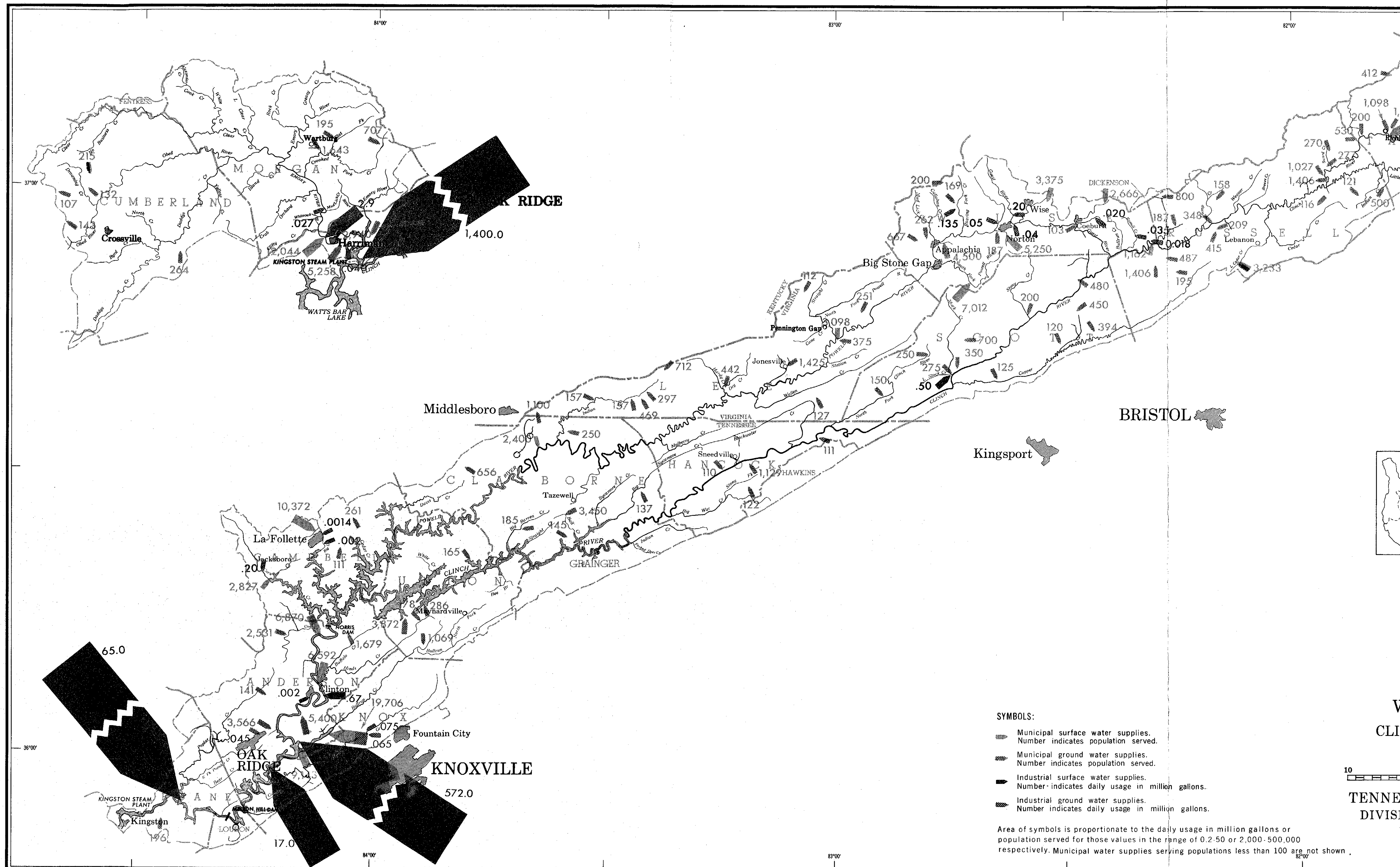
TIES OF WATER

FIGURE IV-3



LITTLE TENNESSEE RIVER

CLINCH RIVER WATERSHED



SYMBOLS:

Municipal surface water supplies. Number indicates population served.

Municipal ground water supplies. Number indicates population served.

Industrial surface water supplies. Number indicates daily usage in million gallons.

Industrial ground water supplies. Number indicates daily usage in million gallons.

Area of symbols is proportionate to the daily usage in million gallons or population served for those values in the range of 0.2-50 or 2,000-500,000 respectively. Municipal water supplies serving populations less than 100 are not shown.

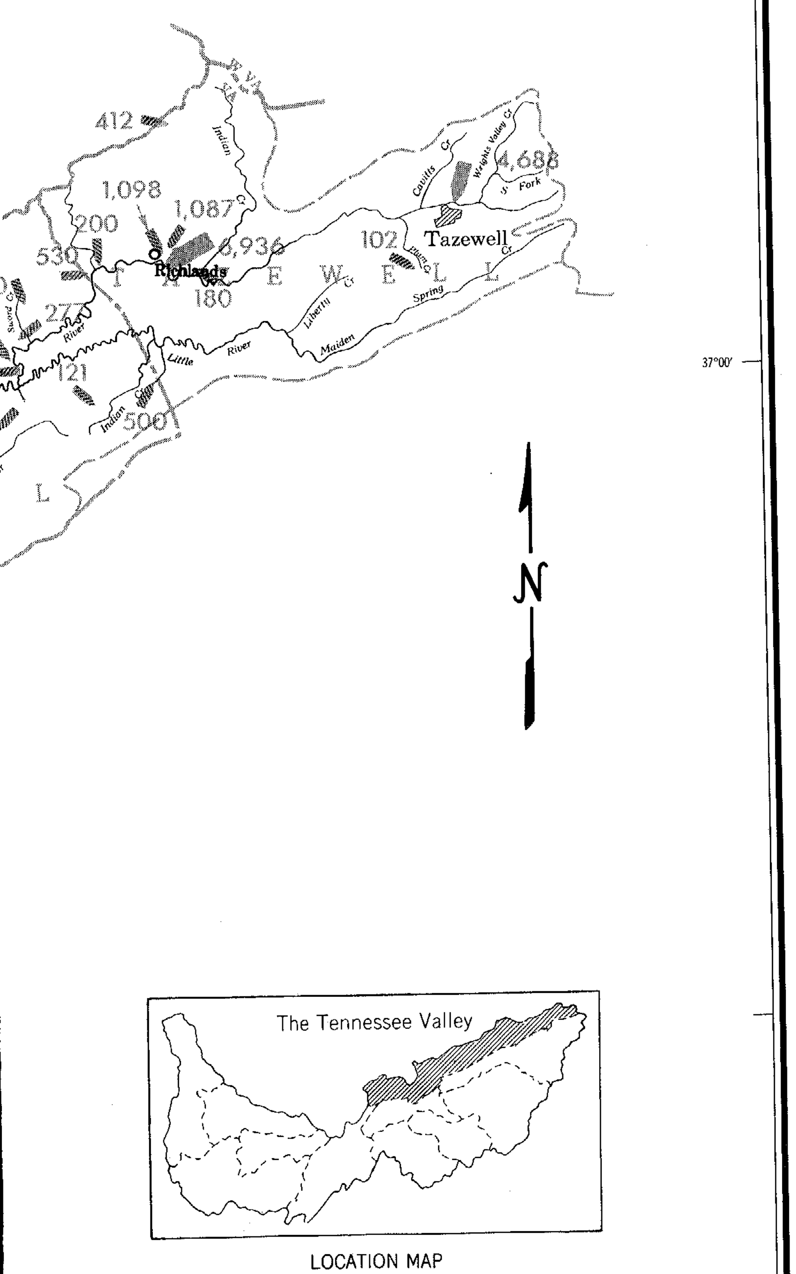


Figure V-1

WATER SUPPLIES

CLINCH RIVER WATERSHED

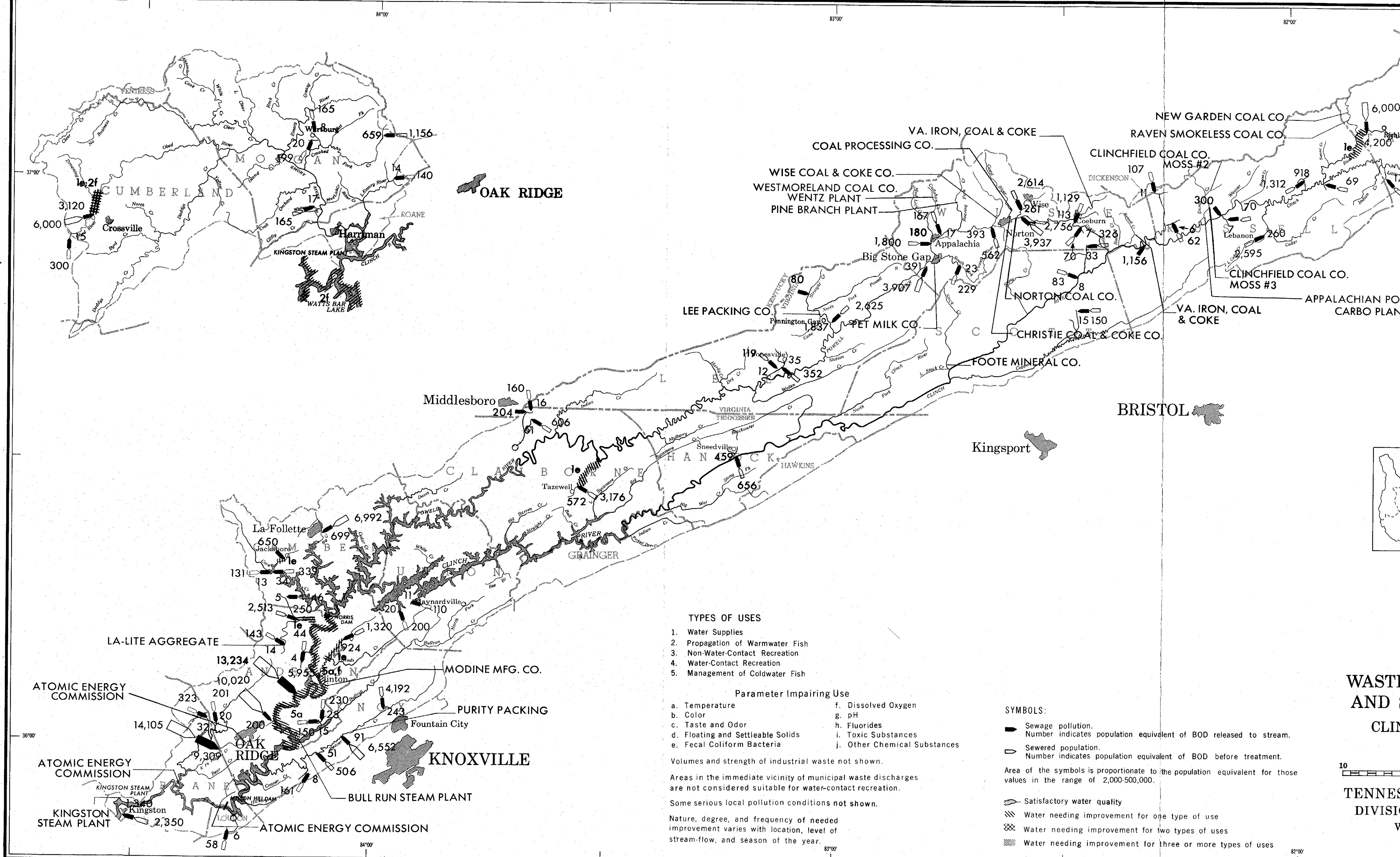
SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

ot shown .



OAK RIDGE
CUMBERLAND
MORGAN
ROANE
Crossville
Wartburg
Harriman
KINGSTON STEAM PLANT
WATTS BAR LAKE
Middlesboro
VIRGINIA
TENNESSEE
KENTUCKY
Kingsport
BRISTOL
NEW GARDEN COAL CO.
RAVEN SMOKELESS COAL CO.
VA. IRON, COAL & COKE
COAL PROCESSING CO.
CLINCHFIELD COAL CO. MOSS #2
WISE COAL & COKE CO.
WESTMORELAND COAL CO. WENTZ PLANT
PINE BRANCH PLANT
DICKENSON
Wise
Norton
Coeburn
Appalachia
Big Stone Gap
Lebanon
CLINCHFIELD COAL CO. MOSS #3
APPALACHIAN PO
CARBO PLAN
LEE PACKING CO.
Pennington Gap
PET MILK CO.
NORTON COAL CO.
VA. IRON, COAL & COKE
CHRISTIE COAL & COKE CO.
FOOTE MINERAL CO.
Jonesville
Sneedville
HANCOCK
HAWKINS
Tazewell
CLAIBORNE
GRAINGER
La Follette
Jacksboro
CAMPBELL
UNION
Maynardville
NORRIS DAM
LA-LITE AGGREGATE
MODINE MFG. CO.
Clinton
ANDERSON
ATOMIC ENERGY COMMISSION
OAK RIDGE
PURITY PACKING
Fountain City
KNOX
KNOXVILLE
BULL RUN STEAM PLANT
Kingston
KINGSTON STEAM PLANT
LOUDON
TYPES OF USES
1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish
Parameter Impairing Use
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances
Volumes and strength of industrial waste not shown.
Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.
Some serious local pollution conditions not shown.
Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.
SYMBOLS:
Sewage pollution. Number indicates population equivalent of BOD released to stream.
Sewered population. Number indicates population equivalent of BOD before treatment.
Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.
Satisfactory water quality
Water needing improvement for one type of use
Water needing improvement for two types of uses
Water needing improvement for three or more types of uses

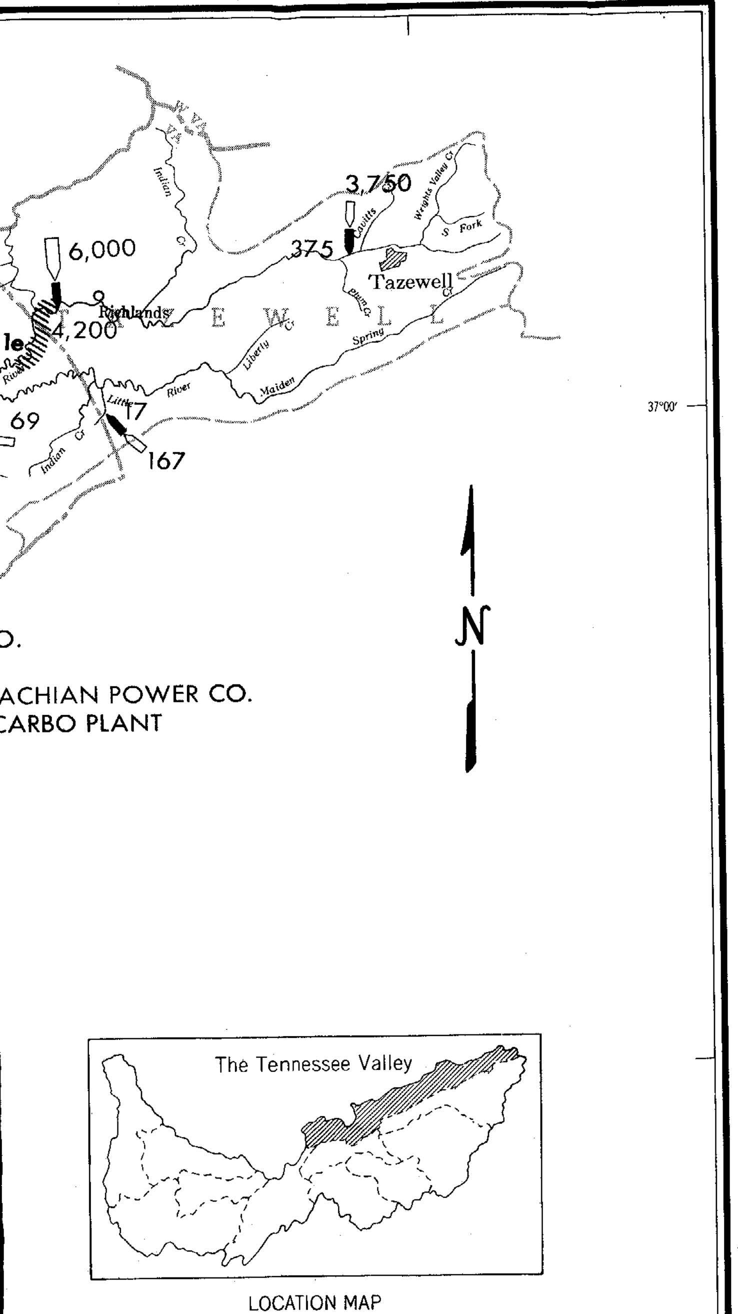


Figure V-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

CLINCH RIVER WATERSHED

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969

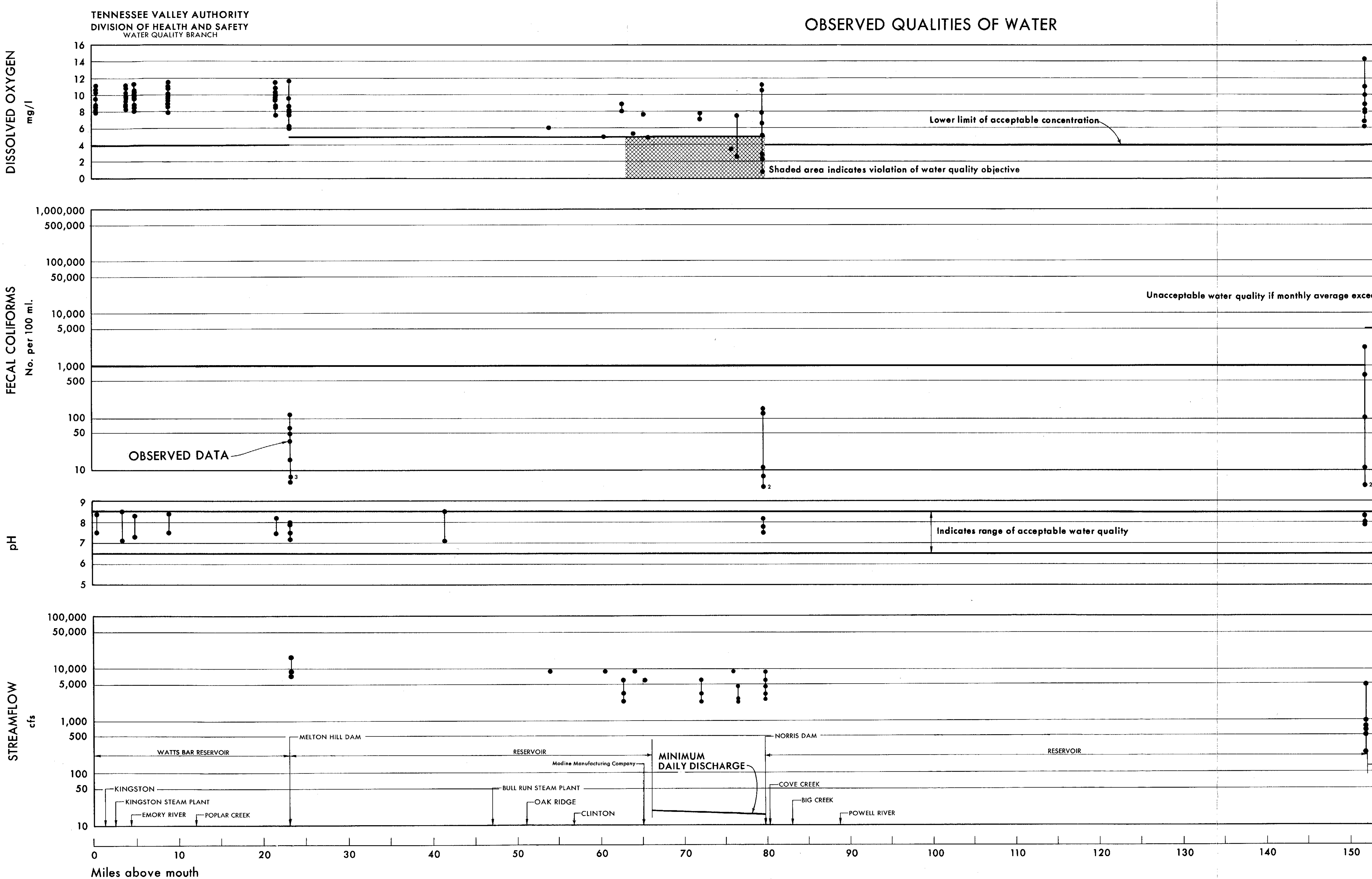
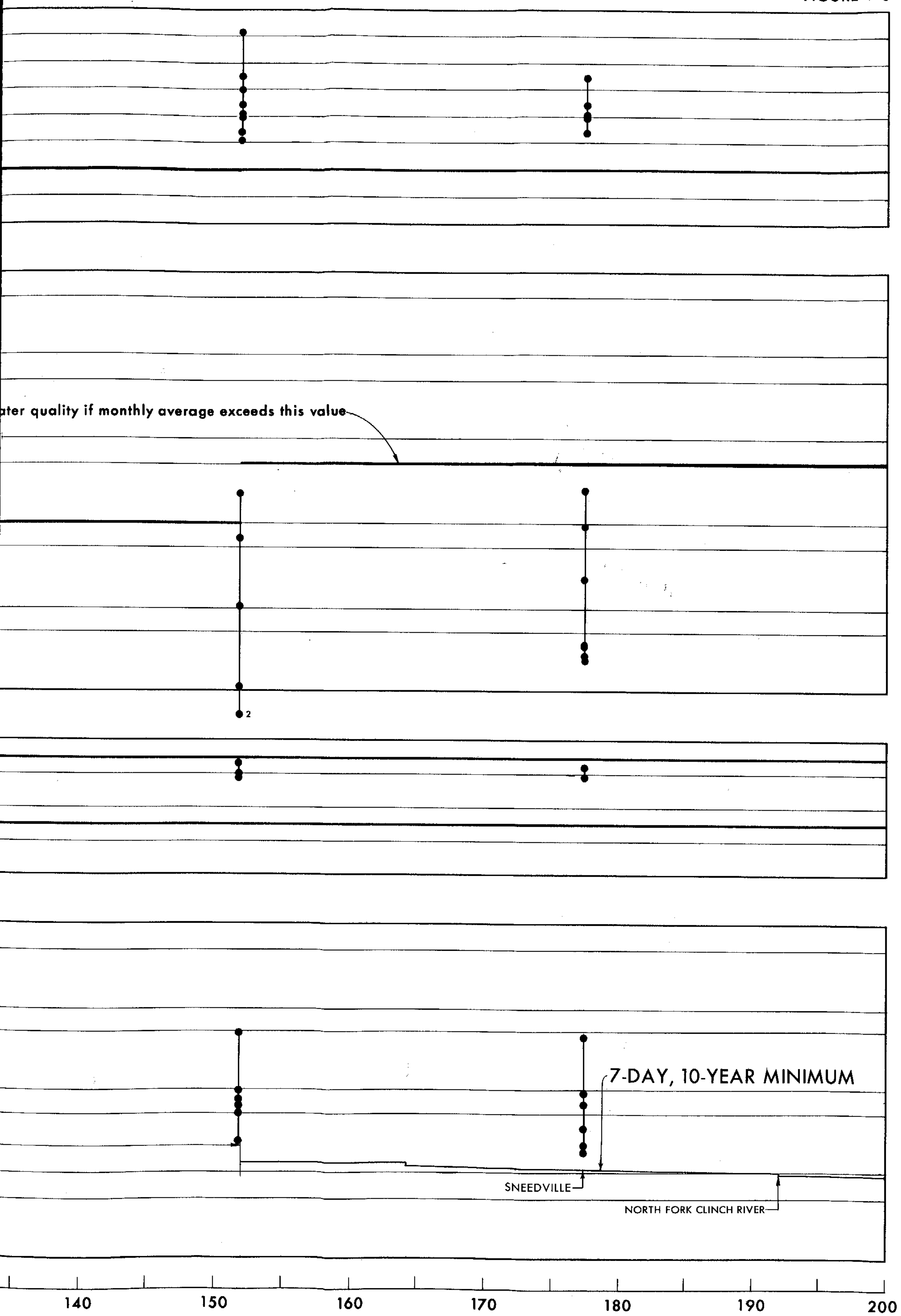

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
OBSERVED QUALITIES OF WATER
DISSOLVED OXYGEN
mg/l
Lower limit of acceptable concentration
Shaded area indicates violation of water quality objective
FECAL COLIFORMS
No. per 100 ml.
Unacceptable water quality if monthly average exce
OBSERVED DATA
pH
Indicates range of acceptable water quality
STREAMFLOW
cfs
WATTS BAR RESERVOIR
MELTON HILL DAM
RESERVOIR
Modine Manufacturing Company
MINIMUM
DAILY DISCHARGE
NORRIS DAM
RESERVOIR
KINGSTON
KINGSTON STEAM PLANT
EMORY RIVER
POPLAR CREEK
BULL RUN STEAM PLANT
OAK RIDGE
CLINTON
COVE CREEK
BIG CREEK
POWELL RIVER
Miles above mouth

FIGURE V-3



CLINCH RIVER

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUALITIES OF WATER

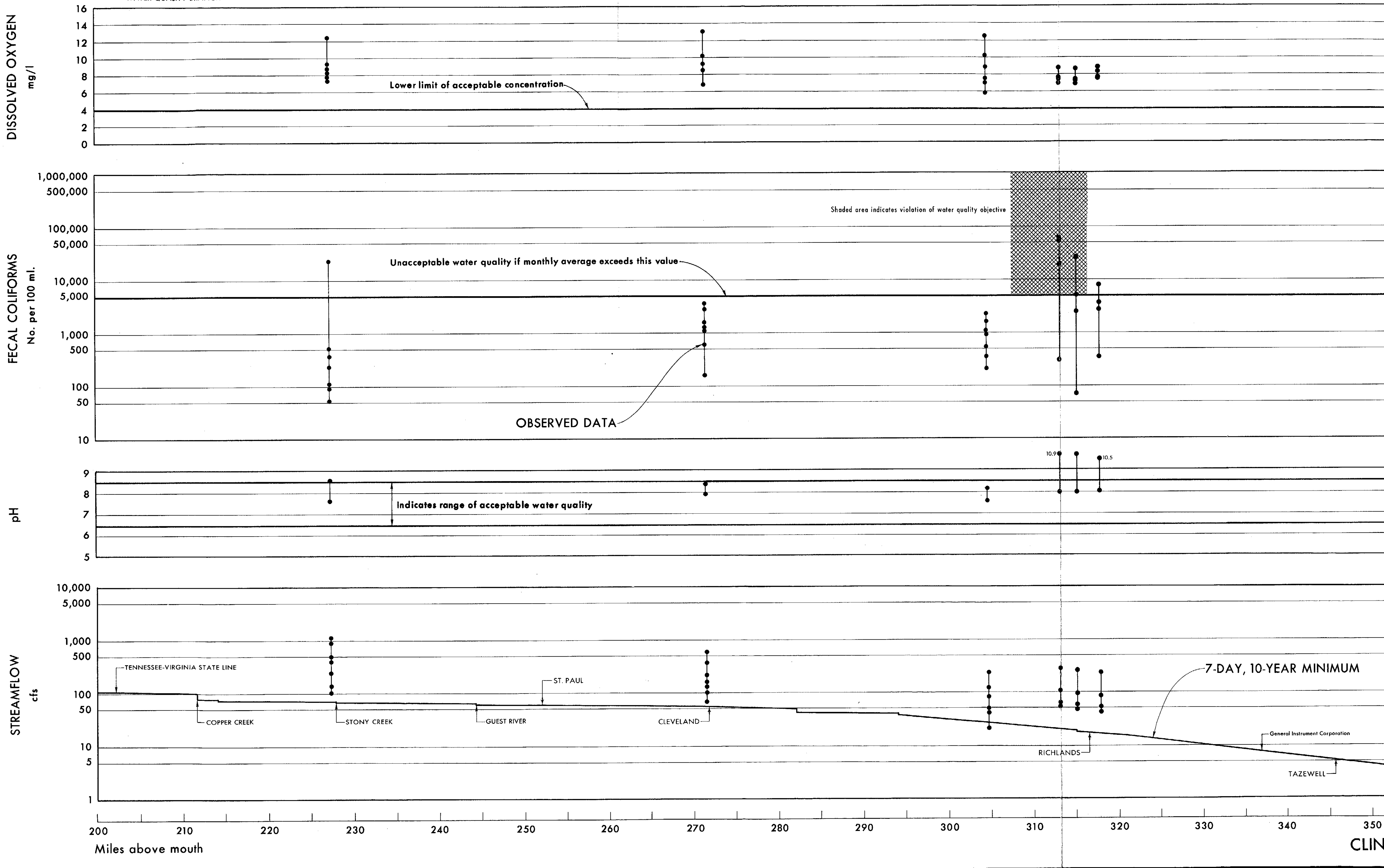
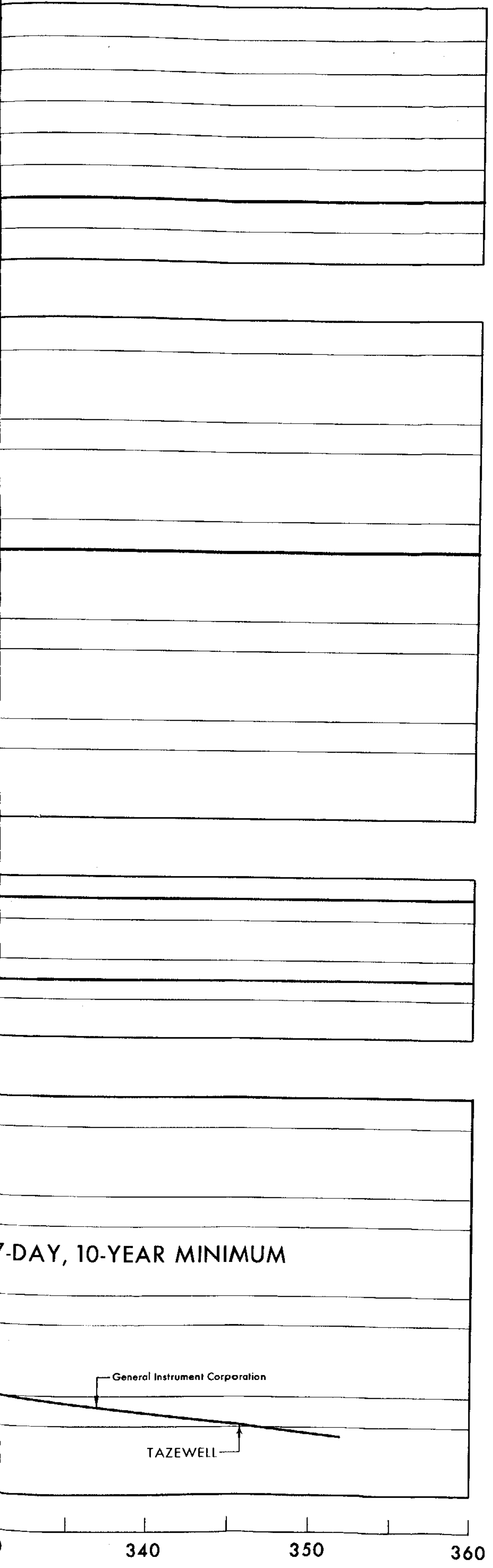


FIGURE V-4


7-DAY, 10-YEAR MINIMUM
General Instrument Corporation
TAZEWELL
340
350
360
CLINCH RIVER

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUALITIES OF WATER

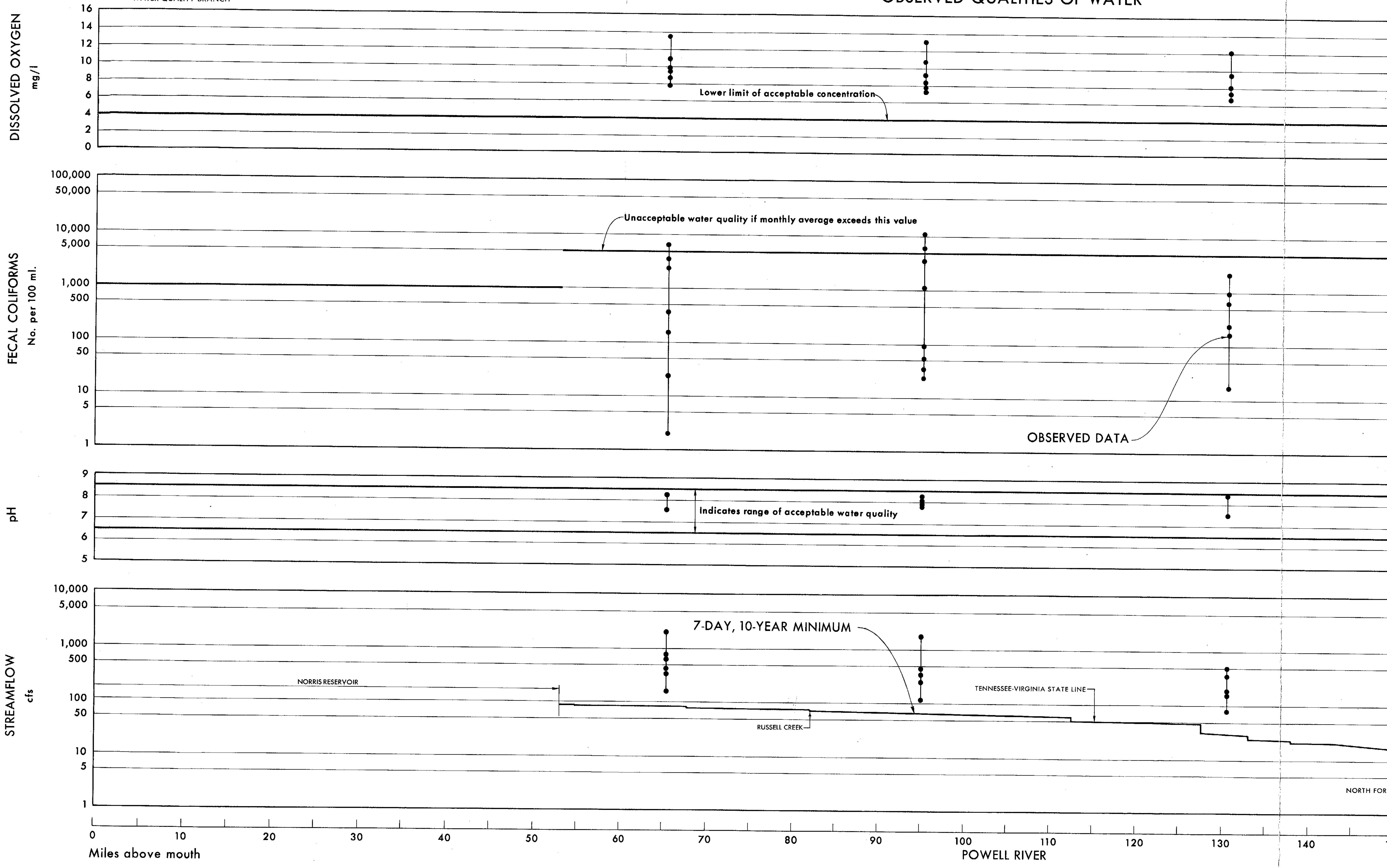
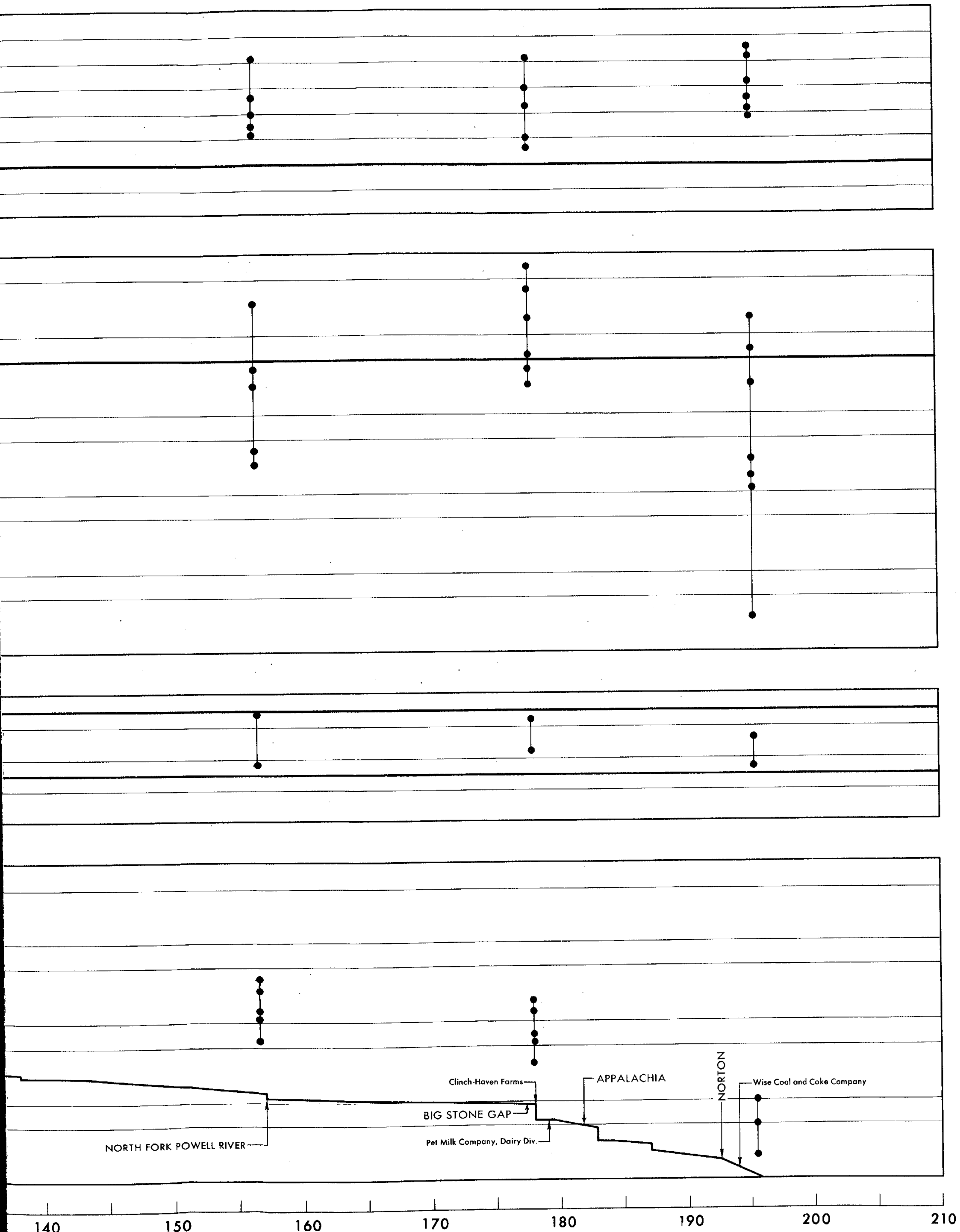
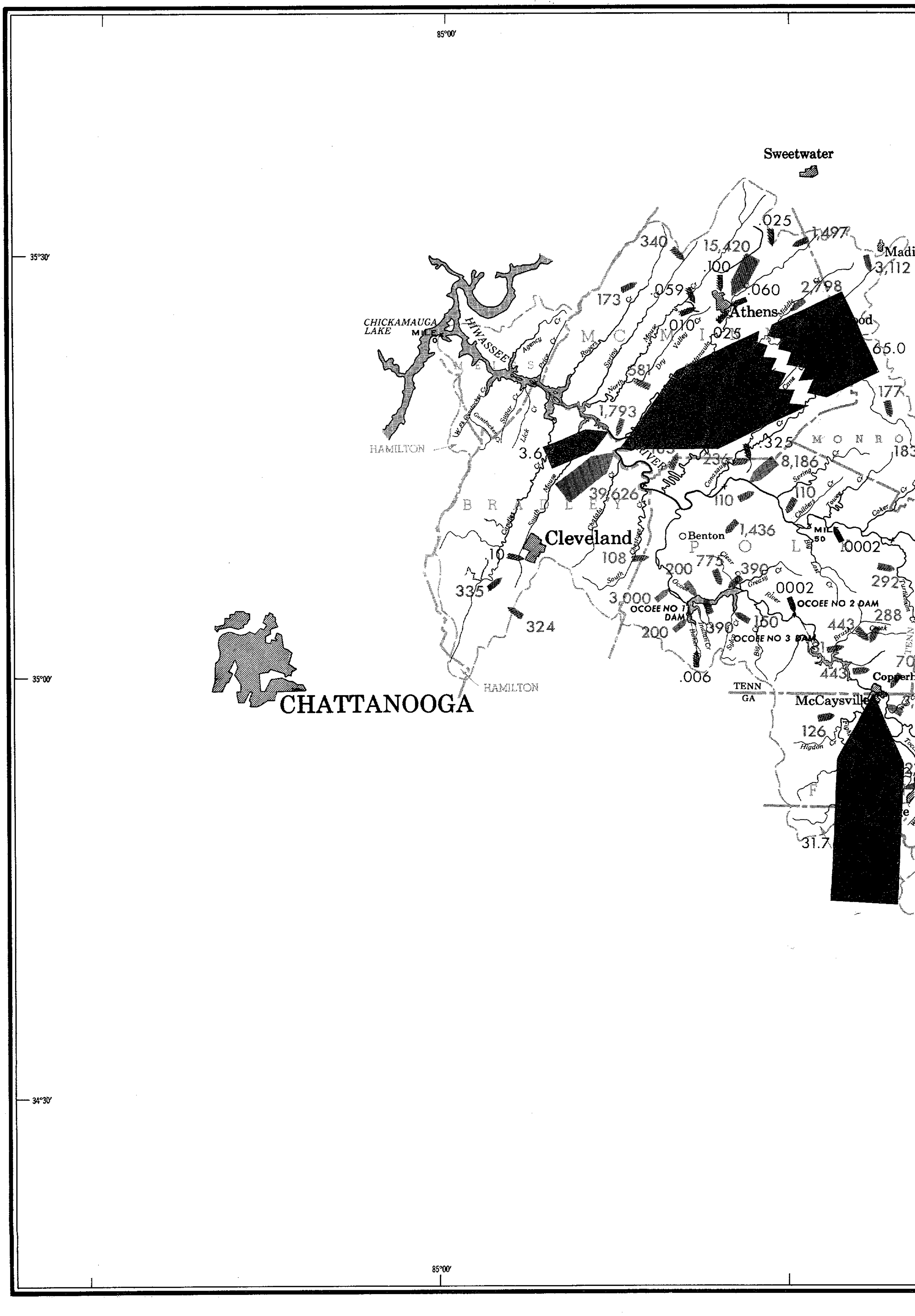


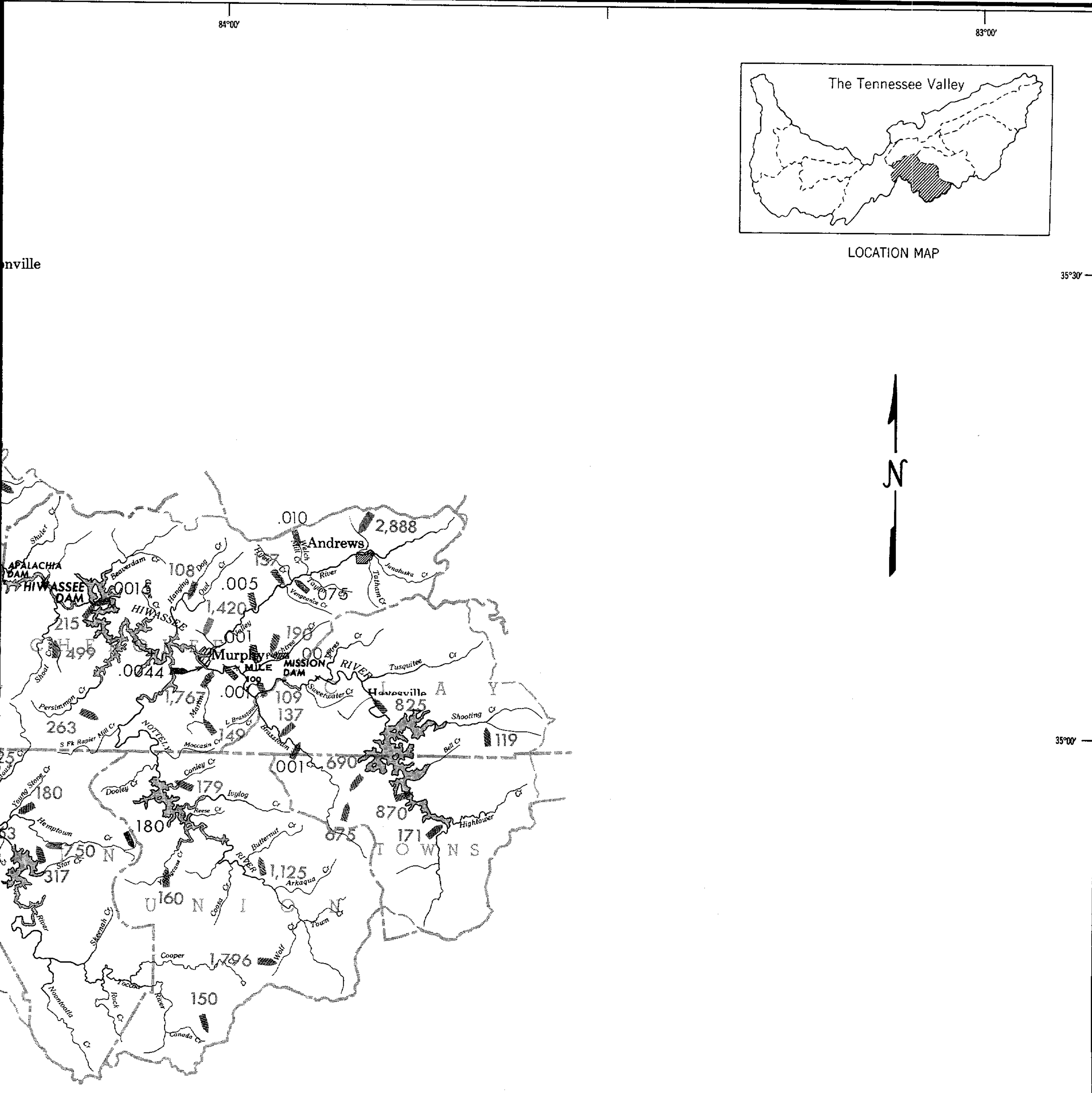
FIGURE V-6



TRIBUTARIES OF CLINCH RIVER

HIWASSEE RIVER WATERSHED


85°00′
35°30′
35°00′
34°30′
Sweetwater
Athens
Madi
CHICKAMAUGA LAKE
HIWASSEE
HAMILTON
Cleveland
Benton
CHATTANOOGA
McCaysville
TENN
GA
OCOEE NO 1 DAM
OCOEE NO 2 DAM
OCOEE NO 3 DAM
M C M I N N
M O N R O
B R A D L E Y
P O L
.025
1,497
340
15,420
.100
3,112
173
.059
.060
2,798
.010
.025
65.0
.581
1,793
177
3.6
.325
183
8,186
39,626
.110
110
1,436
.0002
108
335
.10
200
775
.390
292
.0002
3,000
288
200
390
150
443
324
.006
443
126
31.7



SYMBOLS:

- Municipal surface water supplies. Number indicates population served.
- Municipal ground water supplies. Number indicates population served.
- Industrial surface water supplies. Number indicates daily usage in million gallons.
- Industrial ground water supplies. Number indicates daily usage in million gallons.

Area of symbols is proportionate to the daily usage in million gallons or population served for those values in the range of 0.2-50 or 2,000-500,000 respectively.

Municipal water supplies serving populations less than 100 are not shown.

Figure VI-1

WATER SUPPLIES

HIWASSEE RIVER WATERSHED

SCALE OF MILES

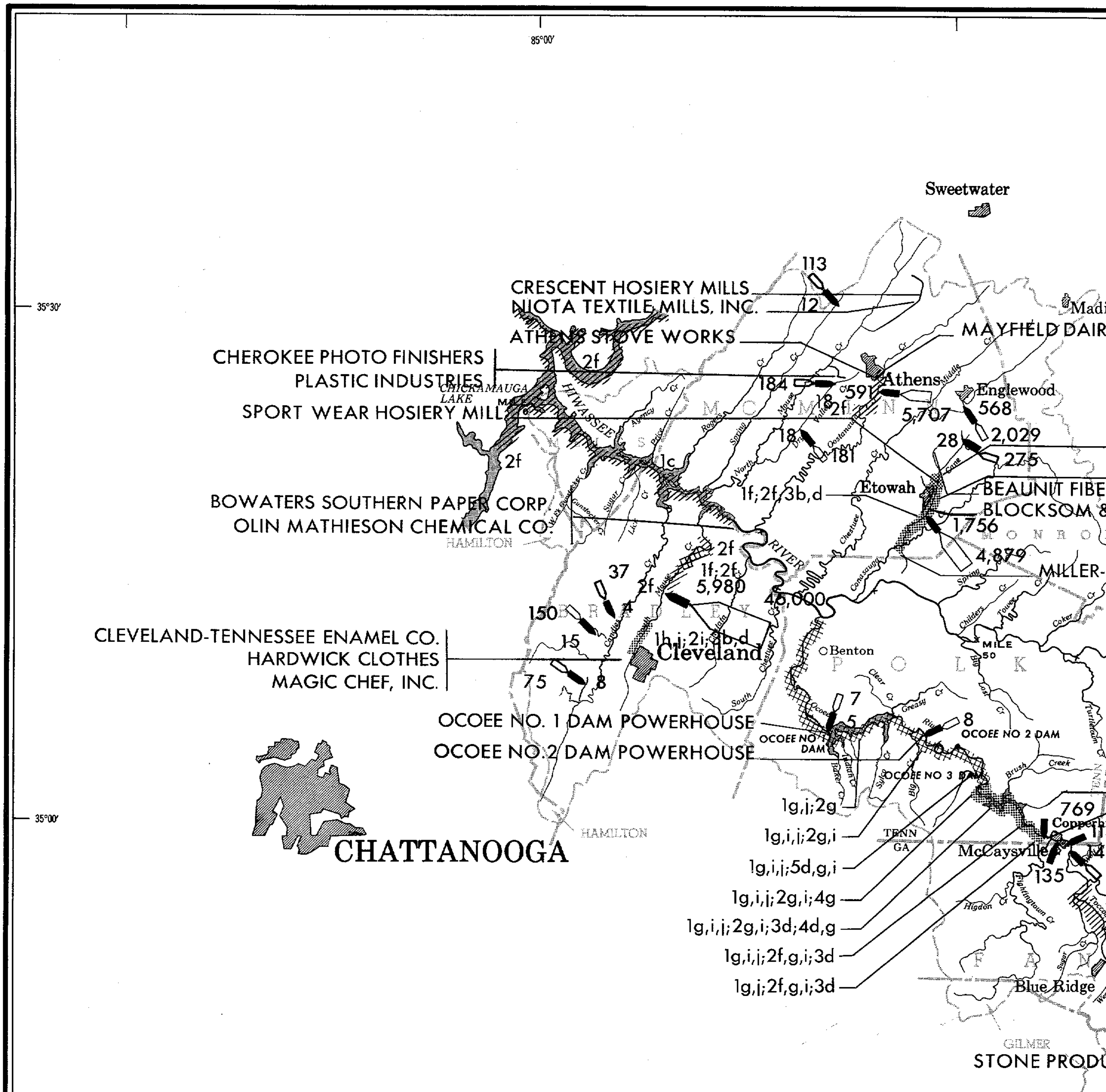
10 0 10 20

TENNESSEE VALLEY AUTHORITY

DIVISION OF HEALTH AND SAFETY

WATER QUALITY BRANCH

JANUARY 1969



TYPES OF USES

1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish

Parameter Impairing Use

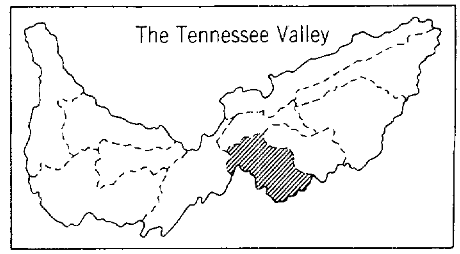
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances

Volumes and strength of industrial waste not shown.

Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.

Some serious local pollution conditions not shown.

Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.



LOCATION MAP

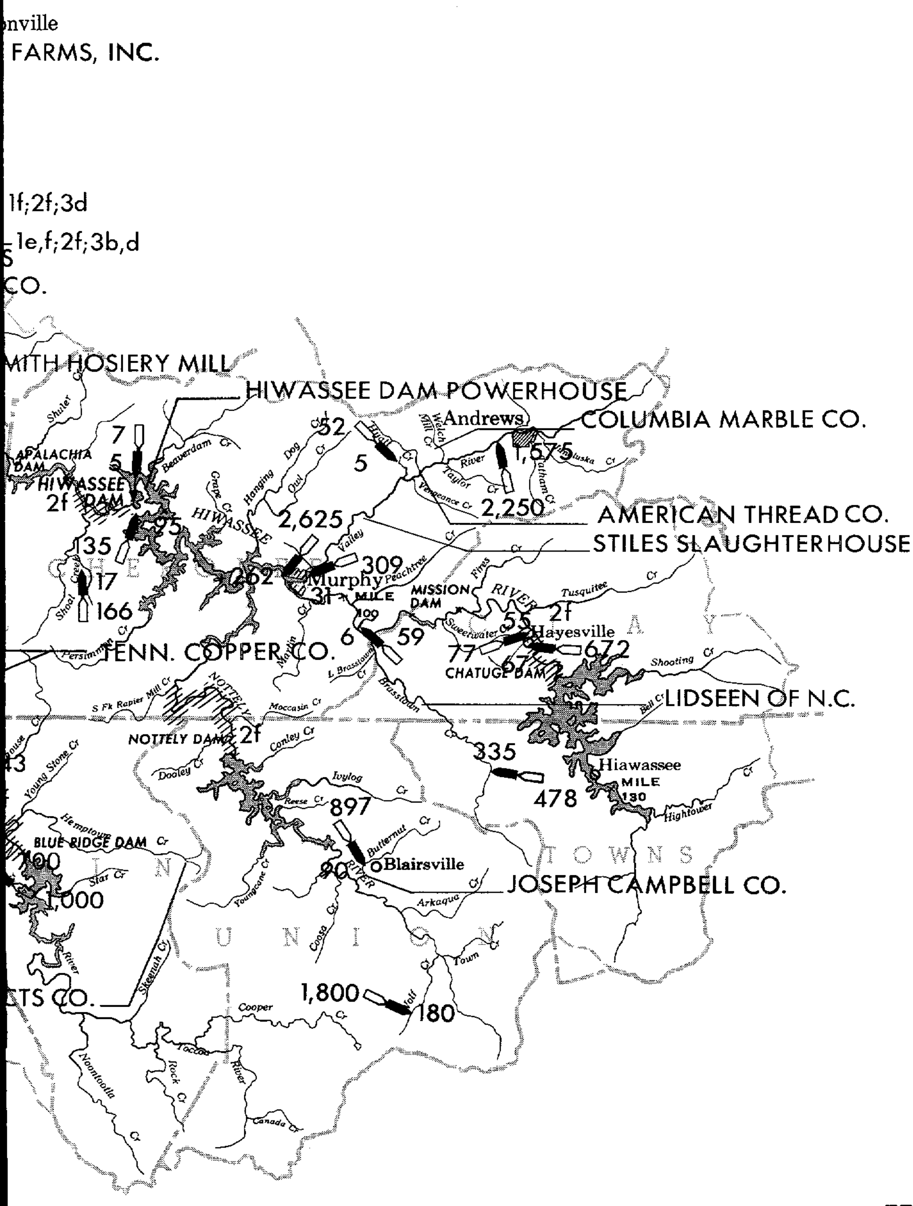


Figure VI-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

HIWASSEE RIVER WATERSHED

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

SYMBOLS:

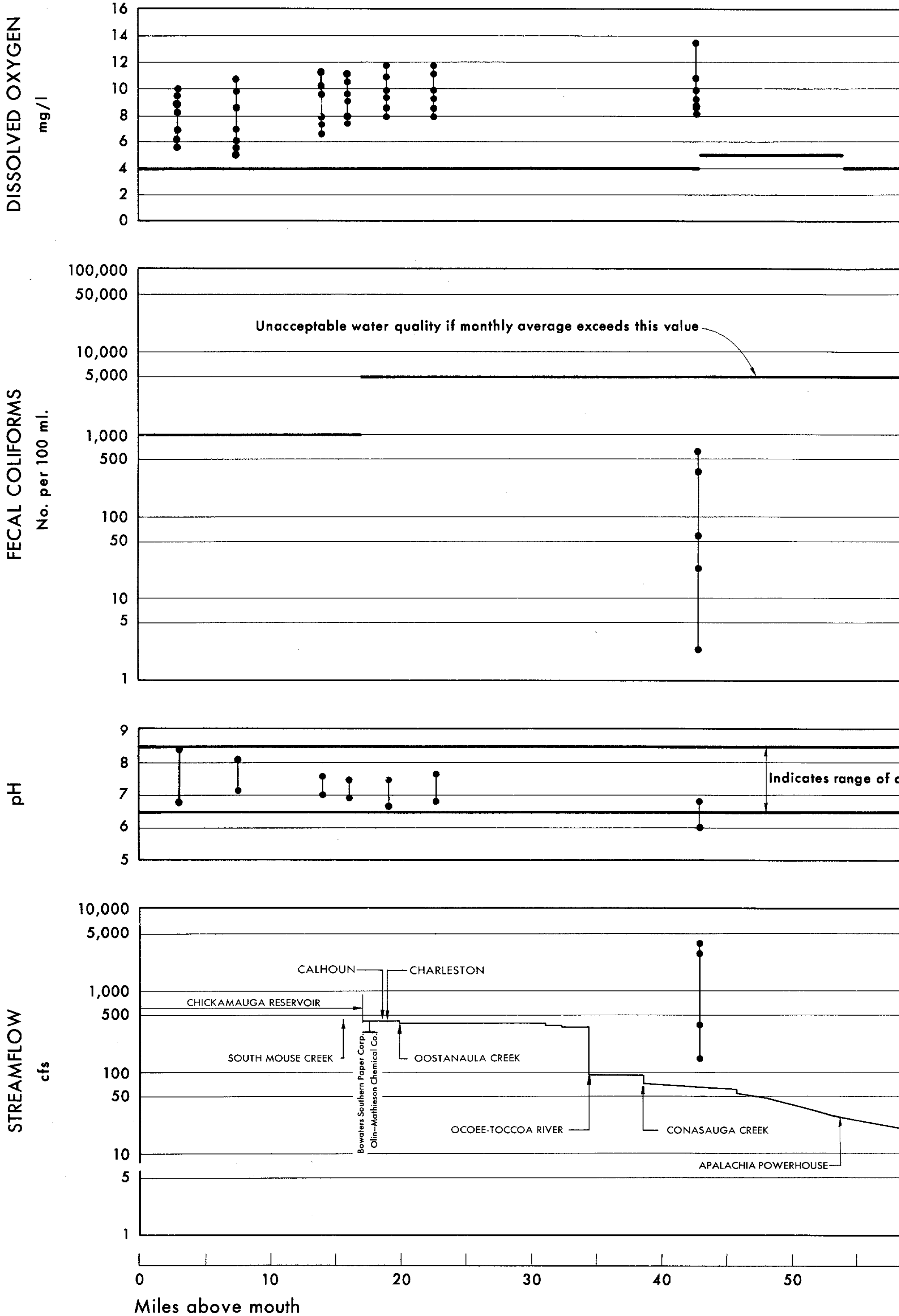
- Sewage pollution. Number indicates population equivalent of BOD released to stream.
- Sewered population. Number indicates population equivalent of BOD before treatment.

Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.

- Satisfactory water quality
- Water needing improvement for one type of use
- Water needing improvement for two types of uses
- Water needing improvement for three or more types of uses

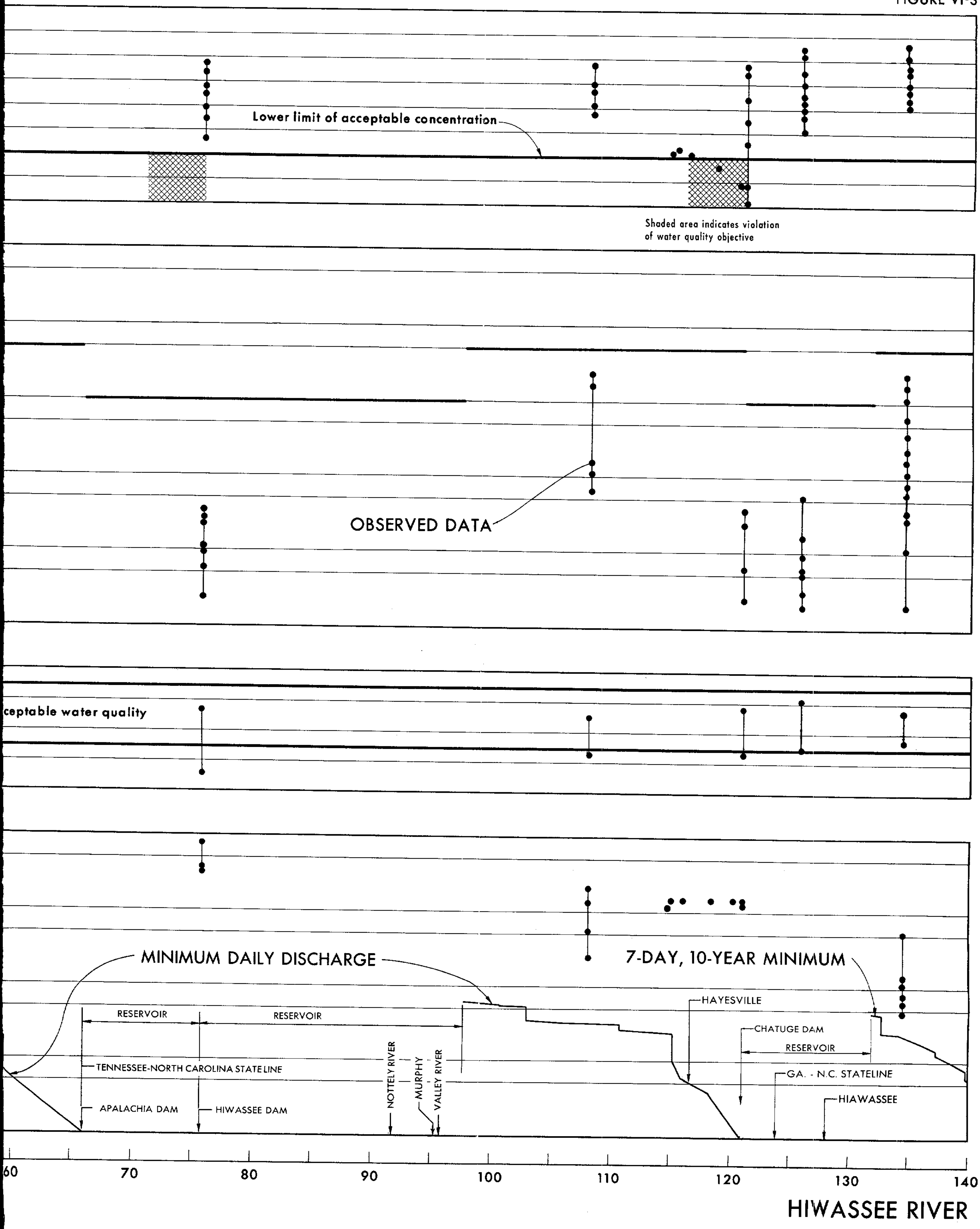
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBS

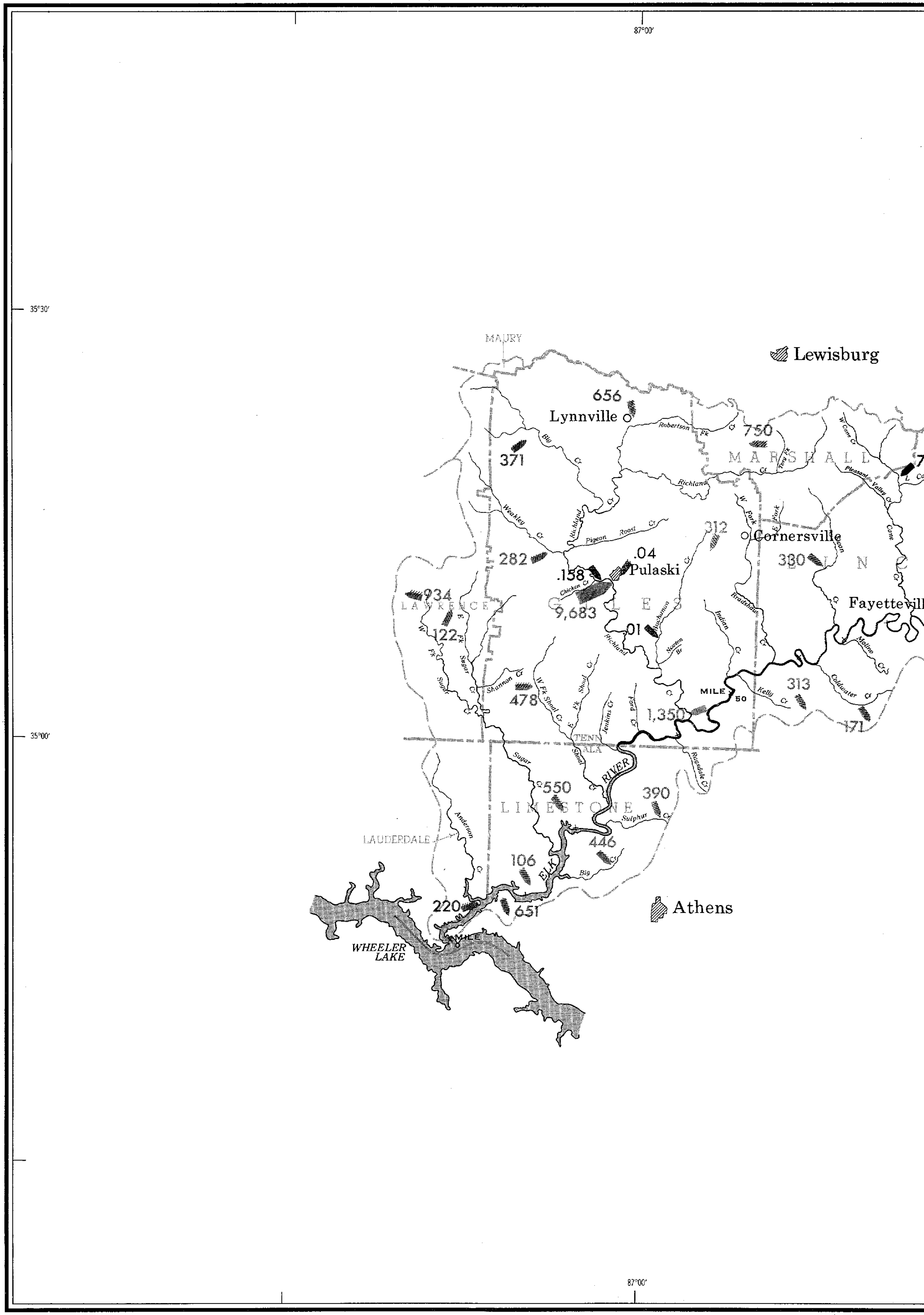


ERVED QUALITIES OF WATER

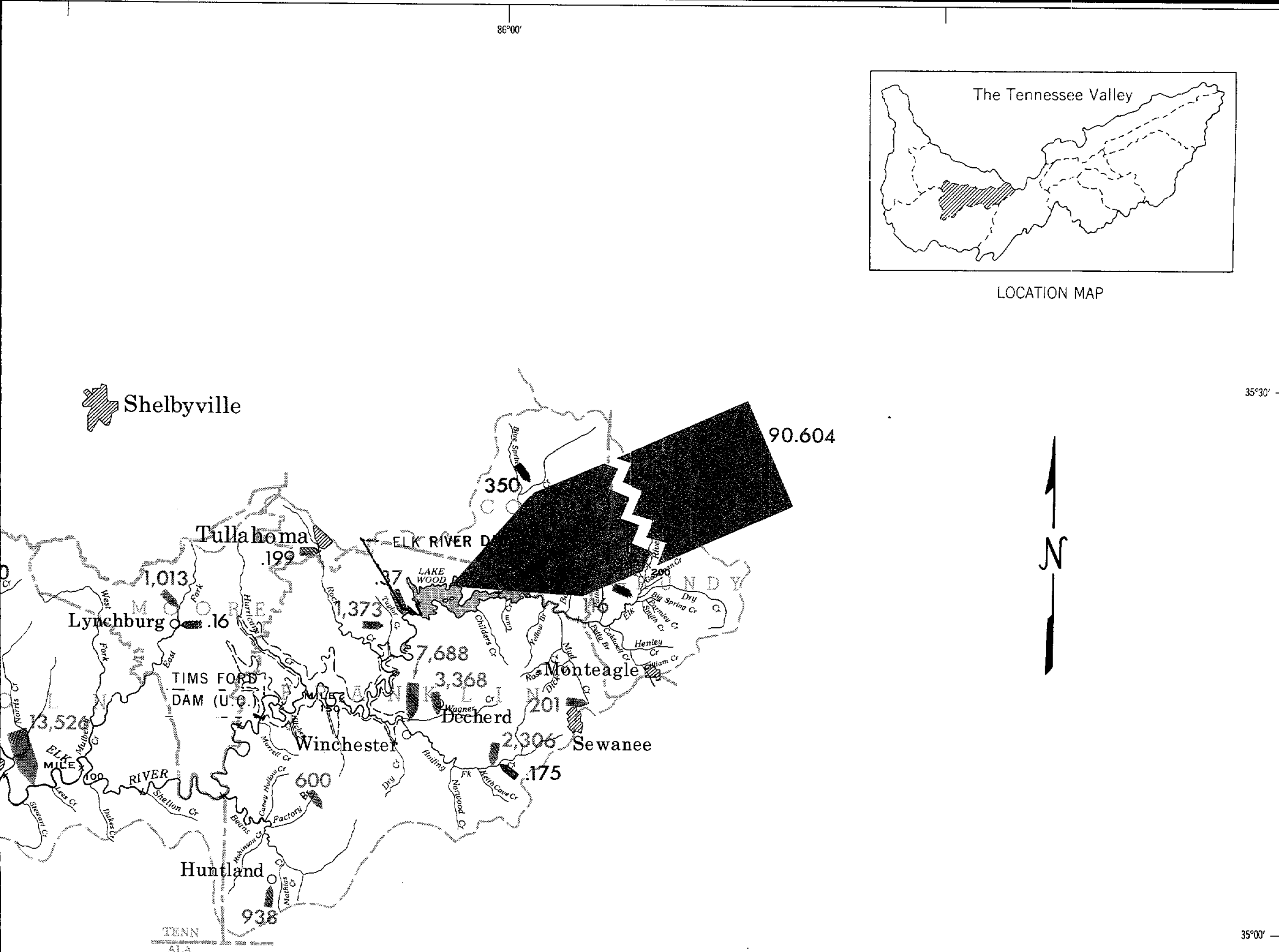
FIGURE VI-3



ELK RIVER WATERSHED



87°00'
35°30'
35°00'
MAURY
Lewisburg
656
Lynnville
Robertson Fk
750
MARSHALL
371
Big Cr
Richland
Weakley Cr
Pigeon Roost Cr
312
Cornersville
.04
Pulaski
282
.158
330
Chicken Cr
934
LAWRENCE
GILES
9,683
122
01
Buchanan
Richland
Bradshaw
Indian
Shannon Cr
478
W Fk Sugar
Sugar
W Fk Shoal Cr
E Fk Shoal
Jenkins Cr
Ford Cr
MILE
50
Kelly Cr
313
Coldwater Cr
Molino
1,350
171
TENN
ALA
Sugar
Shoal
RIVER
550
390
LIMESTONE
Sulphur
Anderson
LAUDERDALE
446
106
ELK
Big
220
651
Athens
MILE
WHEELER
LAKE
87°00'



ymbols:

- Municipal surface water supplies. Number indicates population served.
- Municipal ground water supplies. Number indicates population served.
- Industrial surface water supplies. Number indicates daily usage in million gallons.
- Industrial ground water supplies. Number indicates daily usage in million gallons.

rea of symbols is proportionate to the daily usage in million gallons or opulation served for those values in the range of 0.2-50 or 2,000-500,000 espectively.

unicipal water supplies serving populations less than 100 are not shown.

Figure VII-1

WATER SUPPLIES

ELK RIVER WATERSHED

SCALE OF MILES

10 0 10 20

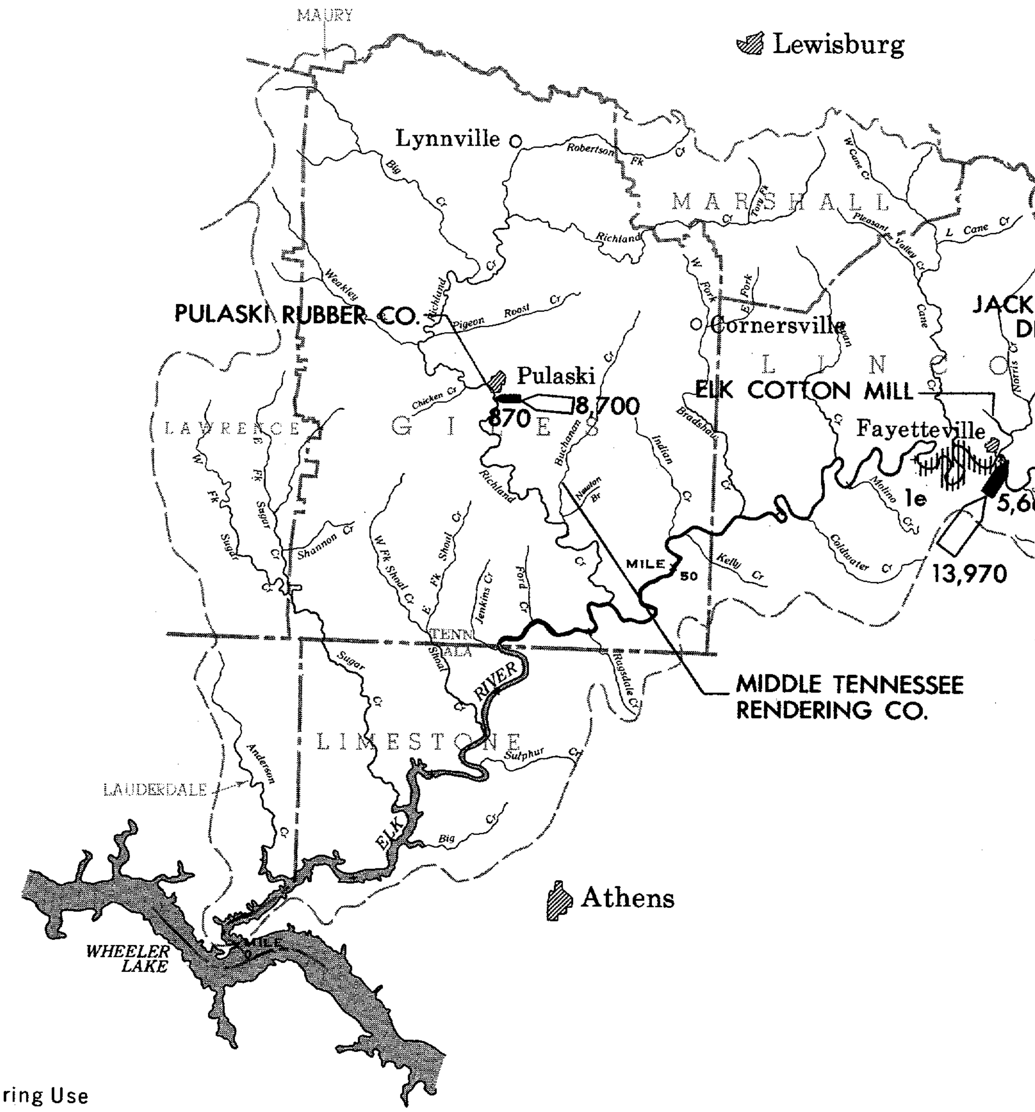
TENNESSEE VALLEY AUTHORITY

DIVISION OF HEALTH AND SAFETY

WATER QUALITY BRANCH

JANUARY 1969

86°00'



TYPES OF USES

1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish

Parameter Impairing Use

a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances

Volumes and strength of industrial waste not shown.

Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.

Some serious local pollution conditions not shown.

Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.

SYMBOLS:

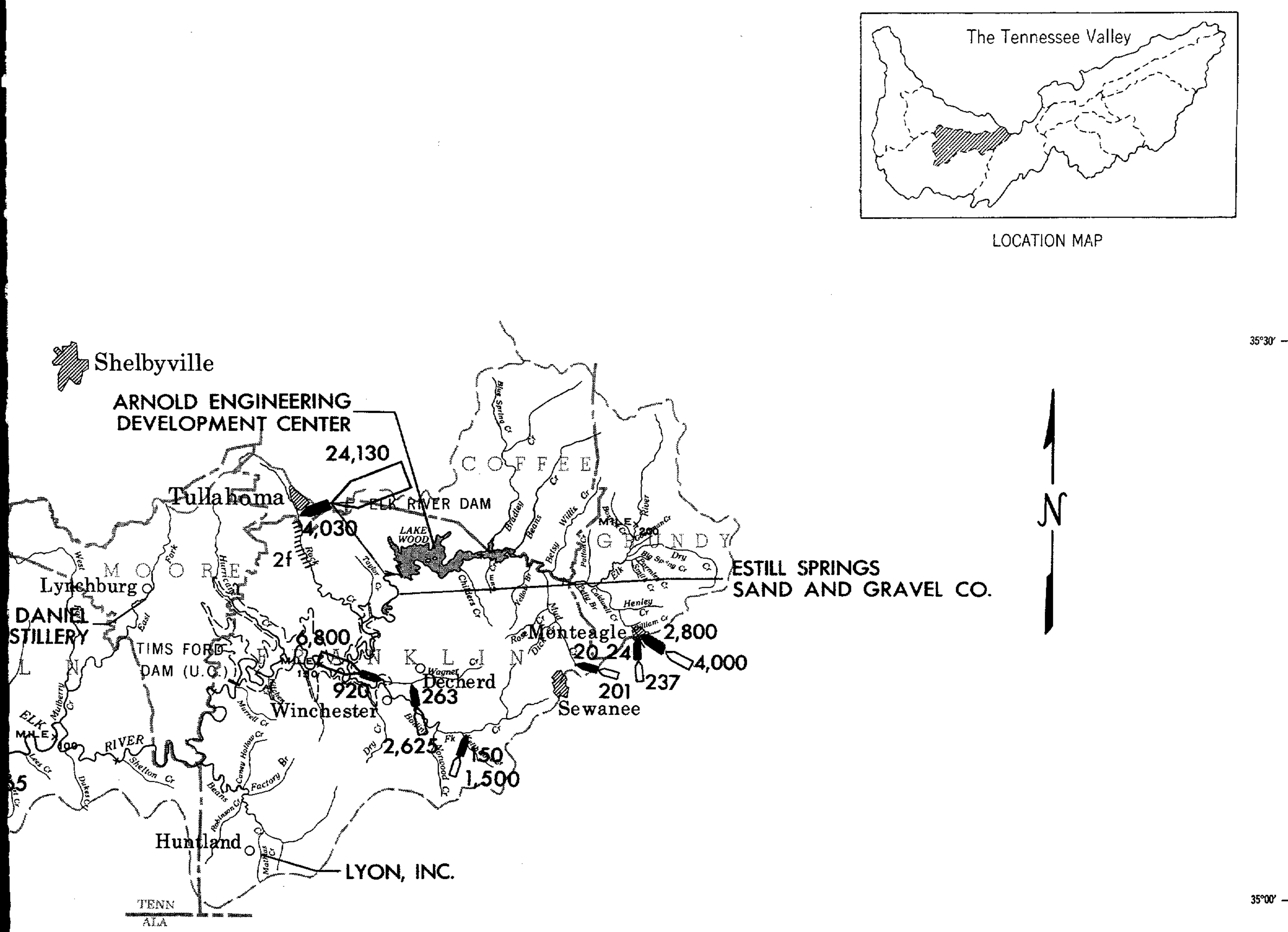
Sewage
Number

Sewered
Number

Area of the
values in th

Satisfac
Water r
Water r
Water r

87°00'



pollution.
indicates population equivalent of BOD released to stream.

population.
indicates population equivalent of BOD before treatment.

symbols is proportionate to the population equivalent for those
range of 2,000-500,000.

tory water quality

eeding improvement for one type of use

eeding improvement for two types of uses

eeding improvement for three or more types of uses

Figure VII-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

ELK RIVER WATERSHED

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY

DIVISION OF HEALTH AND SAFETY

WATER QUALITY BRANCH

JANUARY 1969

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUALITIES OF WATER

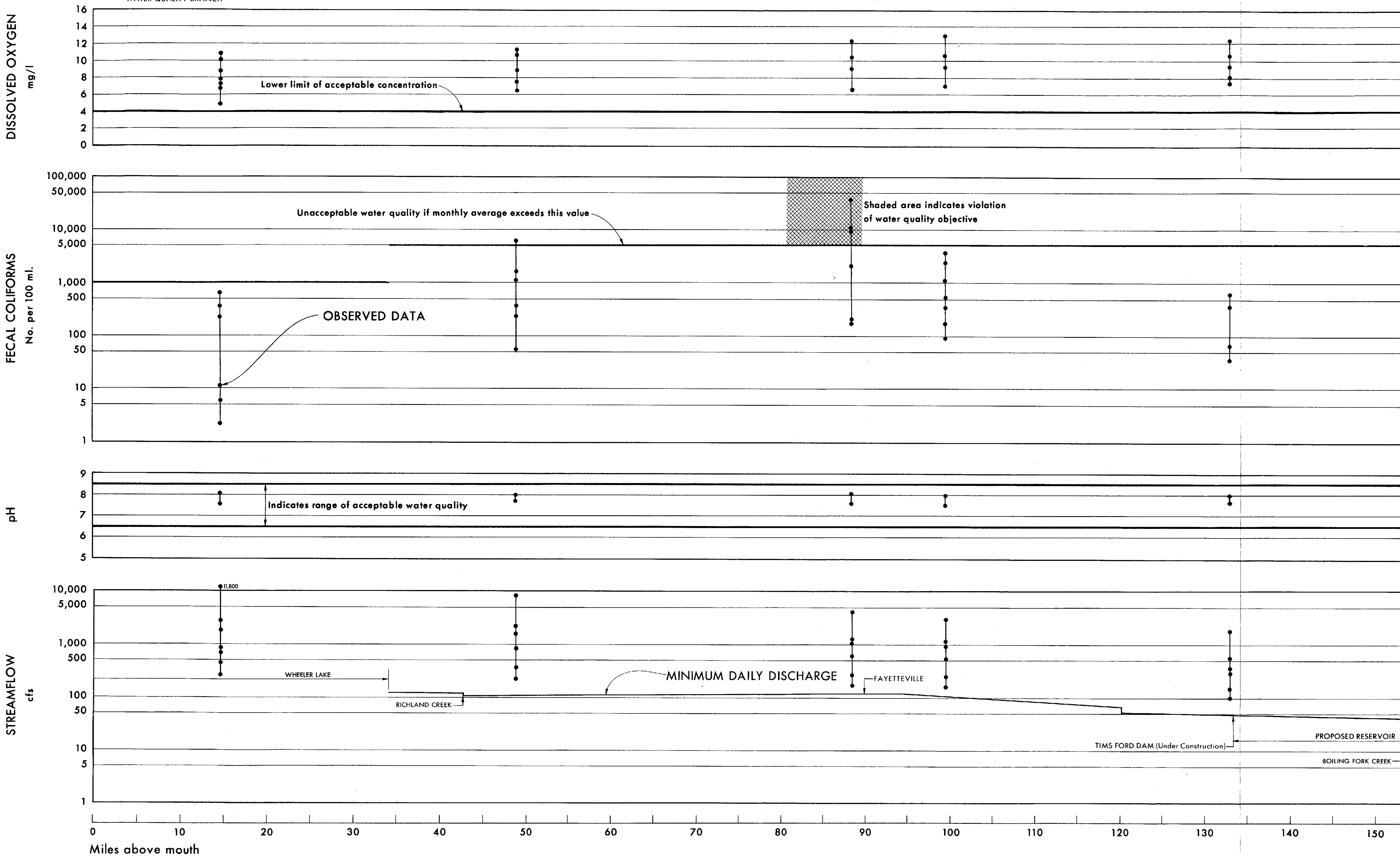
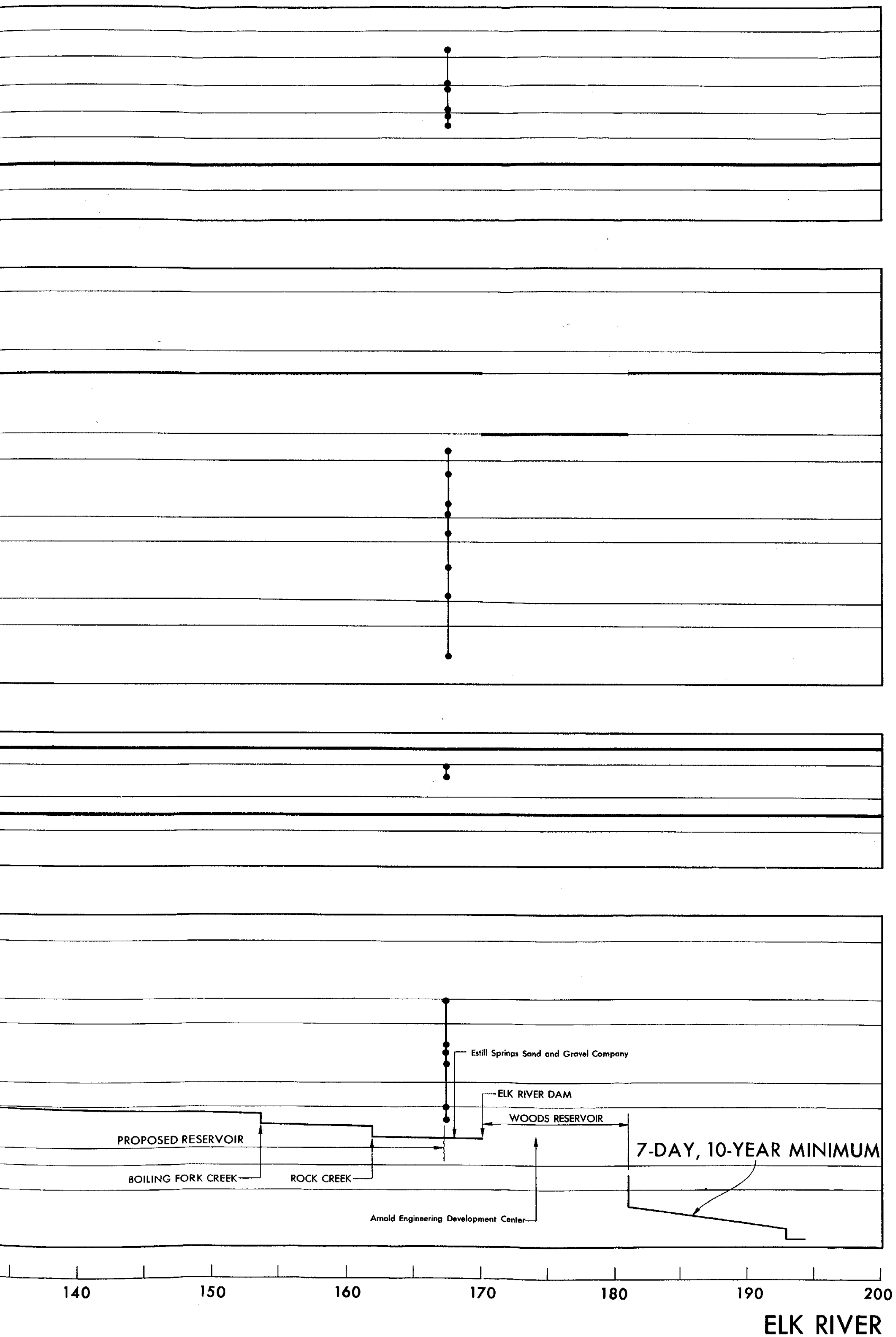
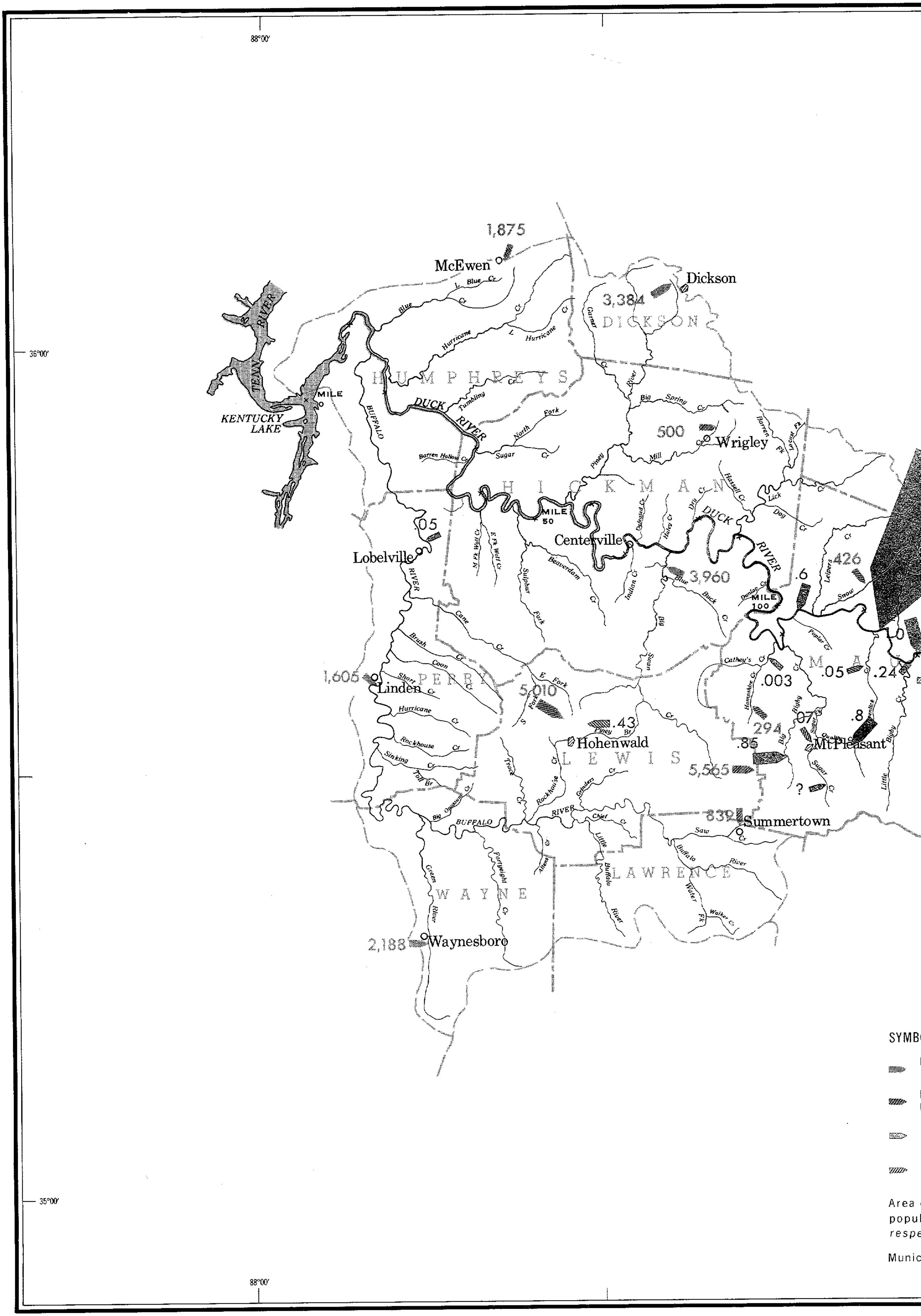


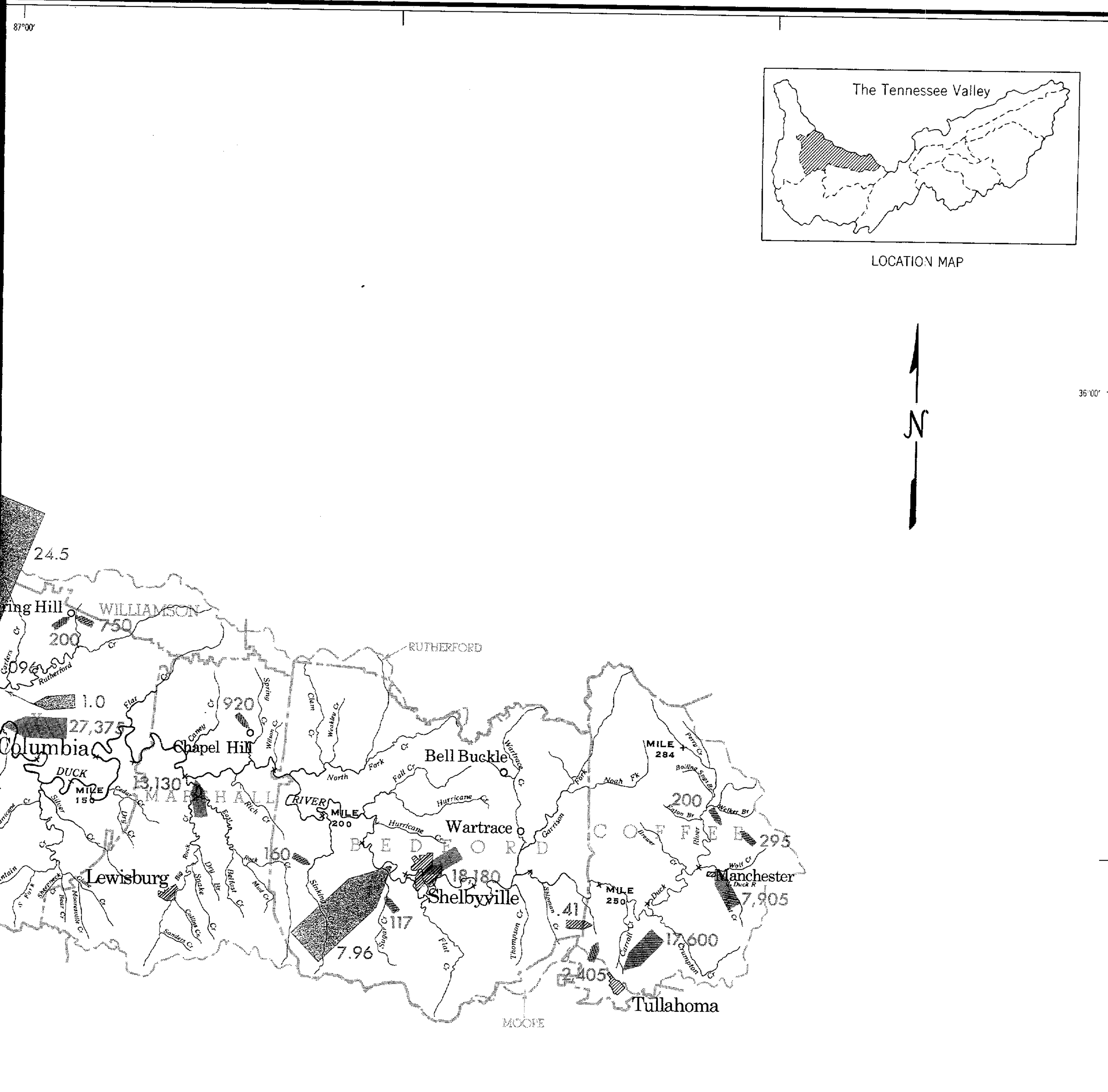
FIGURE VII-3


Estill Springs Sand and Gravel Company
ELK RIVER DAM
WOODS RESERVOIR
PROPOSED RESERVOIR
7-DAY, 10-YEAR MINIMUM
BOILING FORK CREEK
ROCK CREEK
Arnold Engineering Development Center
140
150
160
170
180
190
200
ELK RIVER

DUCK RIVER WATERSHED



88°00'
36°00'
35°00'
1,875
McEwen
Dickson
3,384
DICKSON
HUMPHREYS
TENN RIVER
KENTUCKY LAKE
MILE
DUCK RIVER
BUFFALO
Blue Cr
L Blue Cr
Hurricane Cr
L Hurricane Cr
Tumbling Cr
North Fork
Sugar Cr
Barren Hollow Cr
Garner Cr
Big Spring Cr
Mill
500
Wrigley
Piney
HICKMAN
MILE 50
Centerville
3,960
Beaverdam
Sulphur Fork
Indian Cr
Blue Buck Cr
Lick
Dog Cr
Leipers
426
Snow
.6
MILE 100
Duncan Cr
.05
Lobelville
RIVER
Cane Cr
Brush
Coon
Short Cr
1,605
Linden
PERRY
Hurricane Cr
Rockhouse Cr
Sinking Cr
Toll Br
Big Opossum Cr
5,010
E Fork
S Fork
.43
Piney Br
Hohenwald
LEWIS
Swan
Big
Cathey's
.003
Hampshire
.05
.24
294
.07
.8
Mt Pleasant
Bigby
Sugar Cr
.85
5,565
?
839
Summertown
Saw Cr
Buffalo River
RIVER
Chief Cr
Little Buffalo River
LAWRENCE
Trace Cr
Grinders Cr
Rockhouse Cr
Allens Cr
WAYNE
Green River
Forty eight Cr
Weaver Fk
Walker Cr
2,188
Waynesboro



cipal surface water supplies.
per indicates population served.

cipal ground water supplies.
per indicates population served.

trial surface water supplies.
per indicates daily usage in million gallons.

trial ground water supplies.
per indicates daily usage in million gallons.

mbols is proportionate to the daily usage in million gallons or
n served for those values in the range of 0.2-50 or 2,000-500,000
ely.

water supplies serving populations less than 100 are not shown.

Figure VIII-1

WATER SUPPLIES

DUCK RIVER WATERSHED

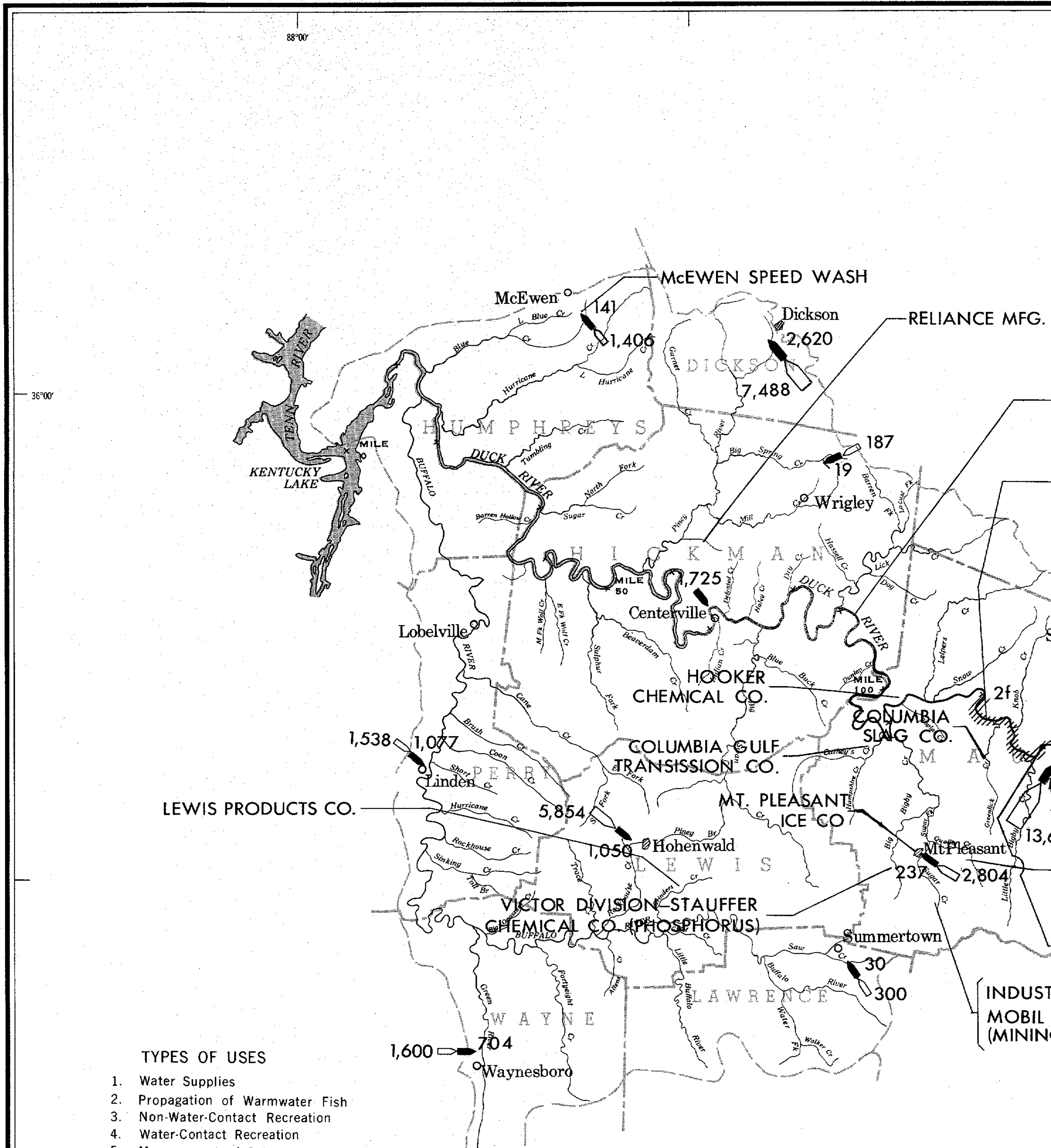
SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

35°00'
87°00'
86°00'



TYPES OF USES

1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish

Parameter Impairing Use

a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances

Volumes and strength of industrial waste not shown.

Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.

Some serious local pollution conditions not shown.

Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.

88°00'

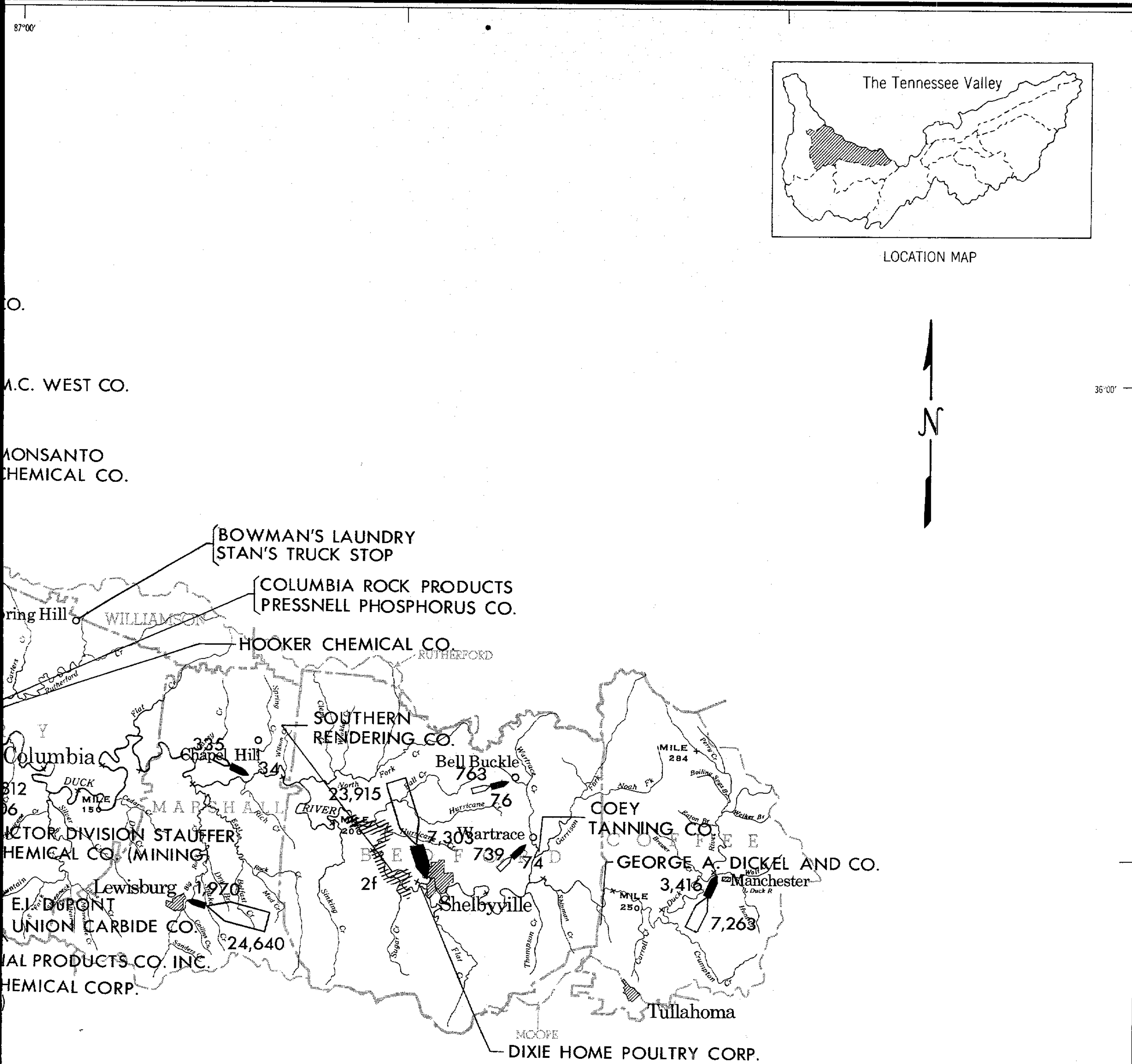


Figure VIII-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

DUCK RIVER WATERSHED

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

SYMBOLS:

Sewage pollution.
Number indicates population equivalent of BOD released to stream.

Sewered population.
Number indicates population equivalent of BOD before treatment.

Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.

Satisfactory water quality

Water needing improvement for one type of use

Water needing improvement for two types of uses

Water needing improvement for three or more types of uses

87°00′ 86°00′ 35°00′

OBSERVED QUALITIES OF WAT

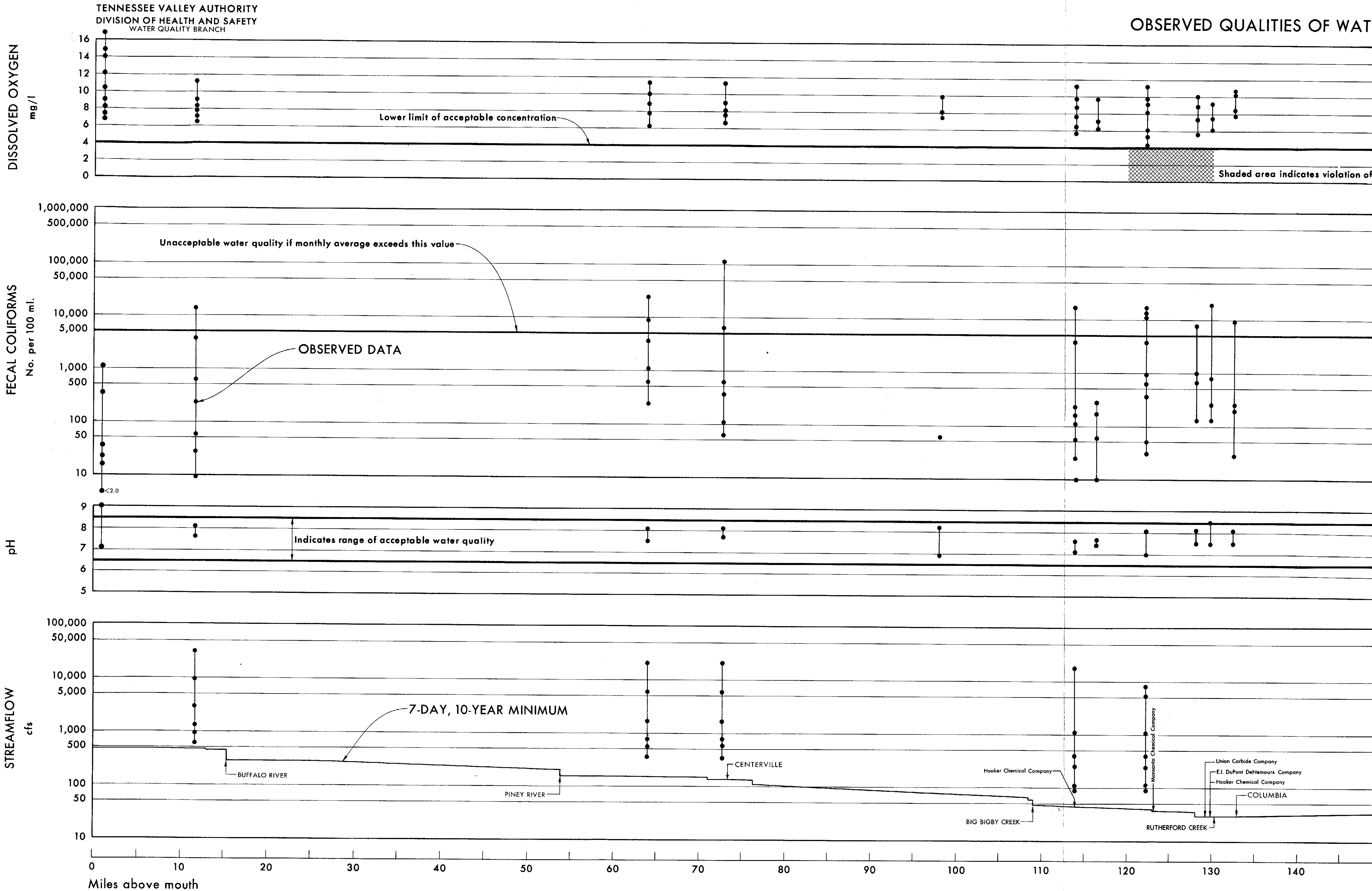
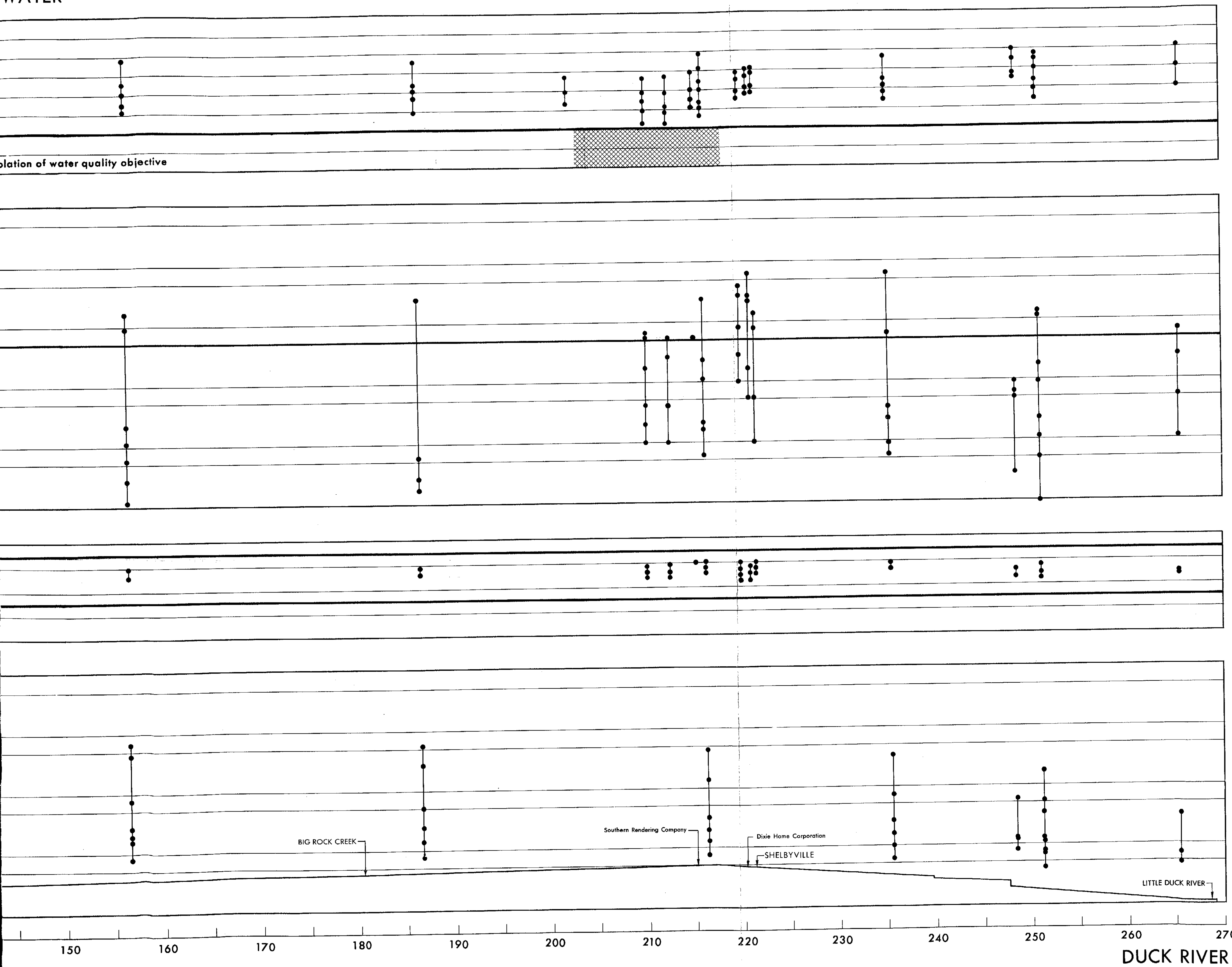
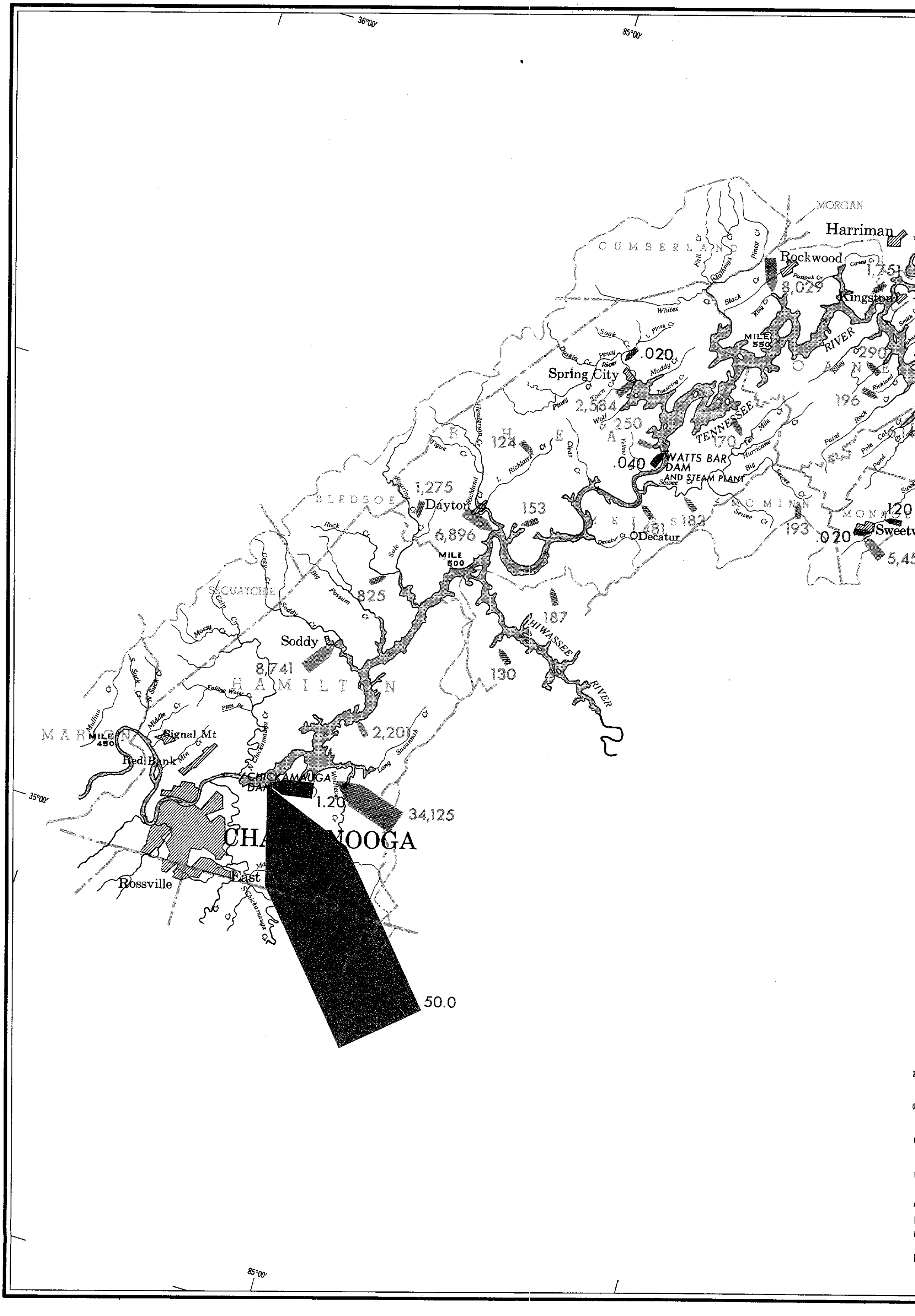


FIGURE VIII-3



THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN KNOXVILLE, TENNESSEE, AND CHICKAMAUGA DAM



36°00′
85°00′
35°00′
MORGAN
CUMBERLAND
BLEDSOE
SEQUATCHIE
RHEA
HAMILTON
MARION
MC MINN
MONROE
MEIGS
ROANE
Harriman
Rockwood
Kingston
Spring City
Dayton
Decatur
Sweetwater
Soddy
Signal Mt
Red Bank
CHATTANOOGA
East
Rossville
WATTS BAR DAM AND STEAM PLANT
CHICKAMAUGA DAM
TENNESSEE RIVER
HIWASSEE RIVER
MILE 550
MILE 500
MILE 450
1,751
8,029
.020
2,584
250
170
.040
290
196
124
1,275
6,896
153
1,481
183
193
120
.020
187
825
8,741
130
2,201
1.20
34,125
50.0

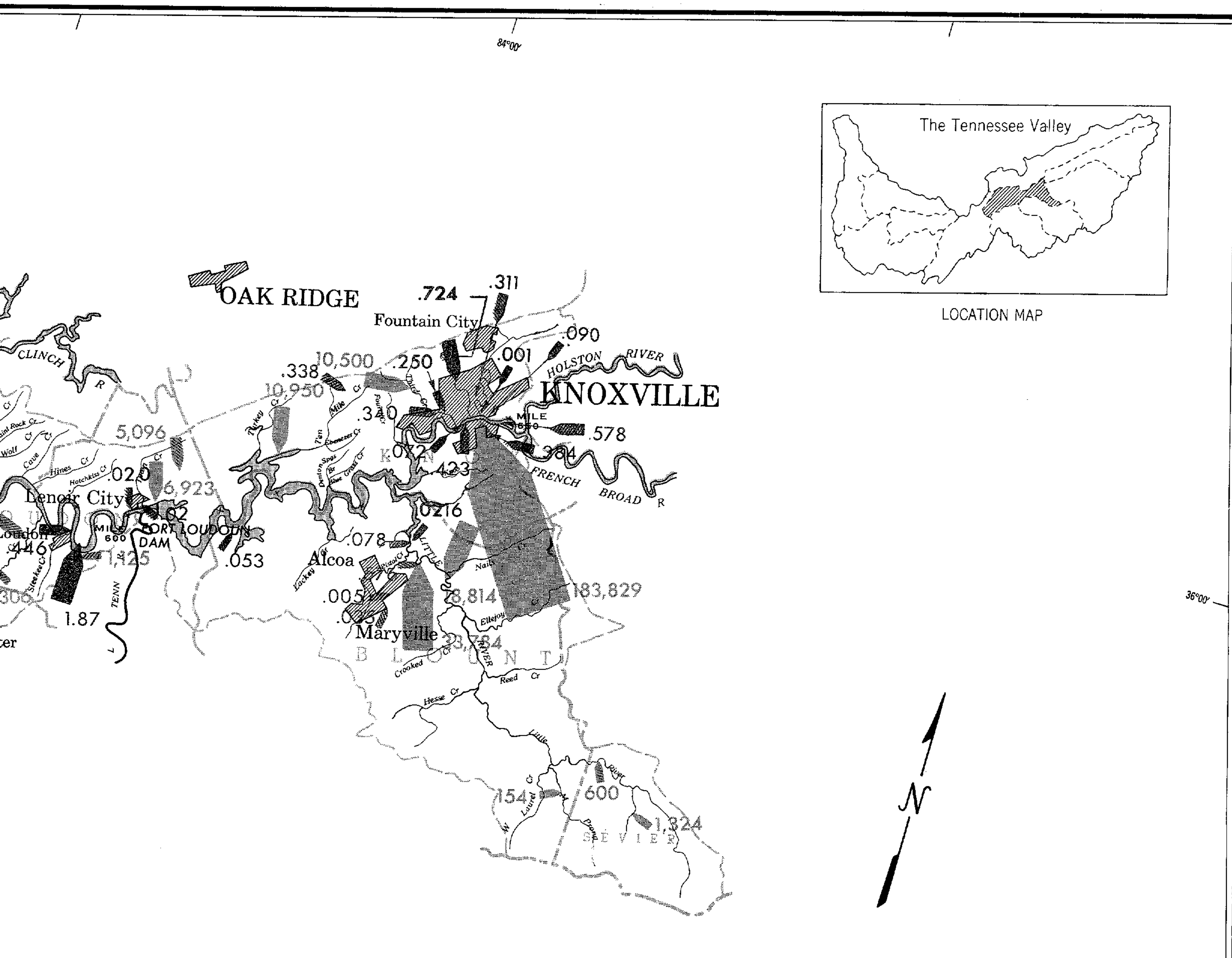


Figure IX-1

WATER SUPPLIES

THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN KNOXVILLE, TENNESSEE AND CHICKAMAUGA DAM

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

MBOLS:

Municipal surface water supplies.
Number indicates population served.

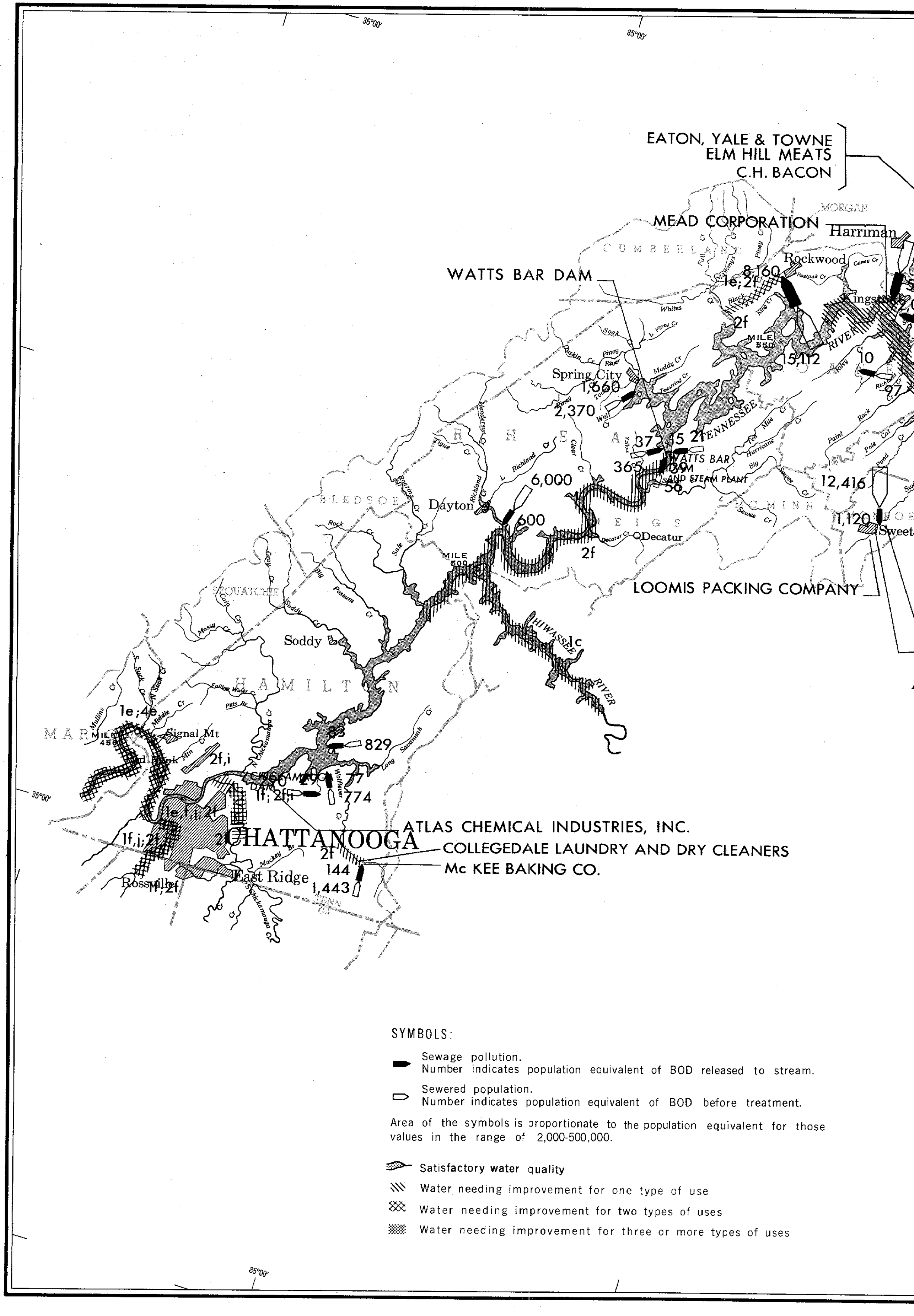
Municipal ground water supplies.
Number indicates population served.

Industrial surface water supplies.
Number indicates daily usage in million gallons.

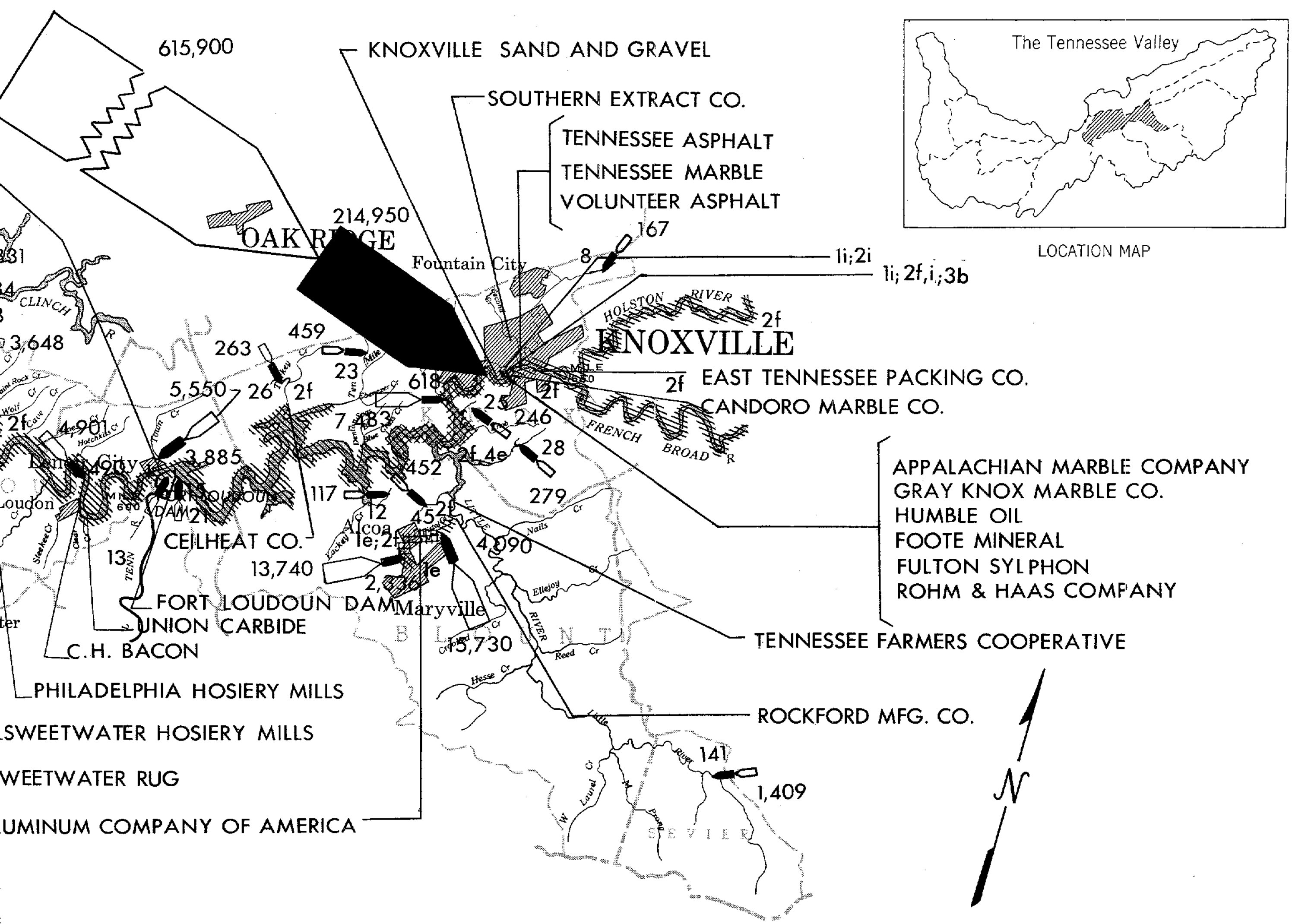
Industrial ground water supplies.
Number indicates daily usage in million gallons.

a of symbols is proportionate to the daily usage in million gallons or
ulation served for those values in the range of 0.2-50 or 2,000-500,000
pectively.

icipal water supplies serving populations less than 100 are not shown.



EATON, YALE & TOWNE
ELM HILL MEATS
C.H. BACON
MEAD CORPORATION
WATTS BAR DAM
LOOMIS PACKING COMPANY
ATLAS CHEMICAL INDUSTRIES, INC.
COLLEGEDALE LAUNDRY AND DRY CLEANERS
Mc KEE BAKING CO.
CHATTANOOGA
East Ridge
Rossville
Signal Mt
Soddy
Dayton
Decatur
Spring City
Rockwood
Harriman
WATTS BAR DAM AND STEAM PLANT
HAMILTON
BLEDSOE
RHEA
MEIGS
CUMBERLAND
MORGAN
SEQUATCHIE
TENNESSEE RIVER
HIWASSEE RIVER
MILE 550
MILE 500
MILE 450
36°00'
85°00'
35°00'
8,160
15,112
1,660
2,370
6,000
600
12,416
1,120
829
774
144
1,443
SYMBOLS:
Sewage pollution.
Number indicates population equivalent of BOD released to stream.
Sewered population.
Number indicates population equivalent of BOD before treatment.
Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.
Satisfactory water quality
Water needing improvement for one type of use
Water needing improvement for two types of uses
Water needing improvement for three or more types of uses



TYPES OF USES

1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish

Parameter Impairing Use

a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances

Volumes and strength of industrial waste not shown.

Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.

Some serious local pollution conditions not shown.

Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.

Figure IX-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

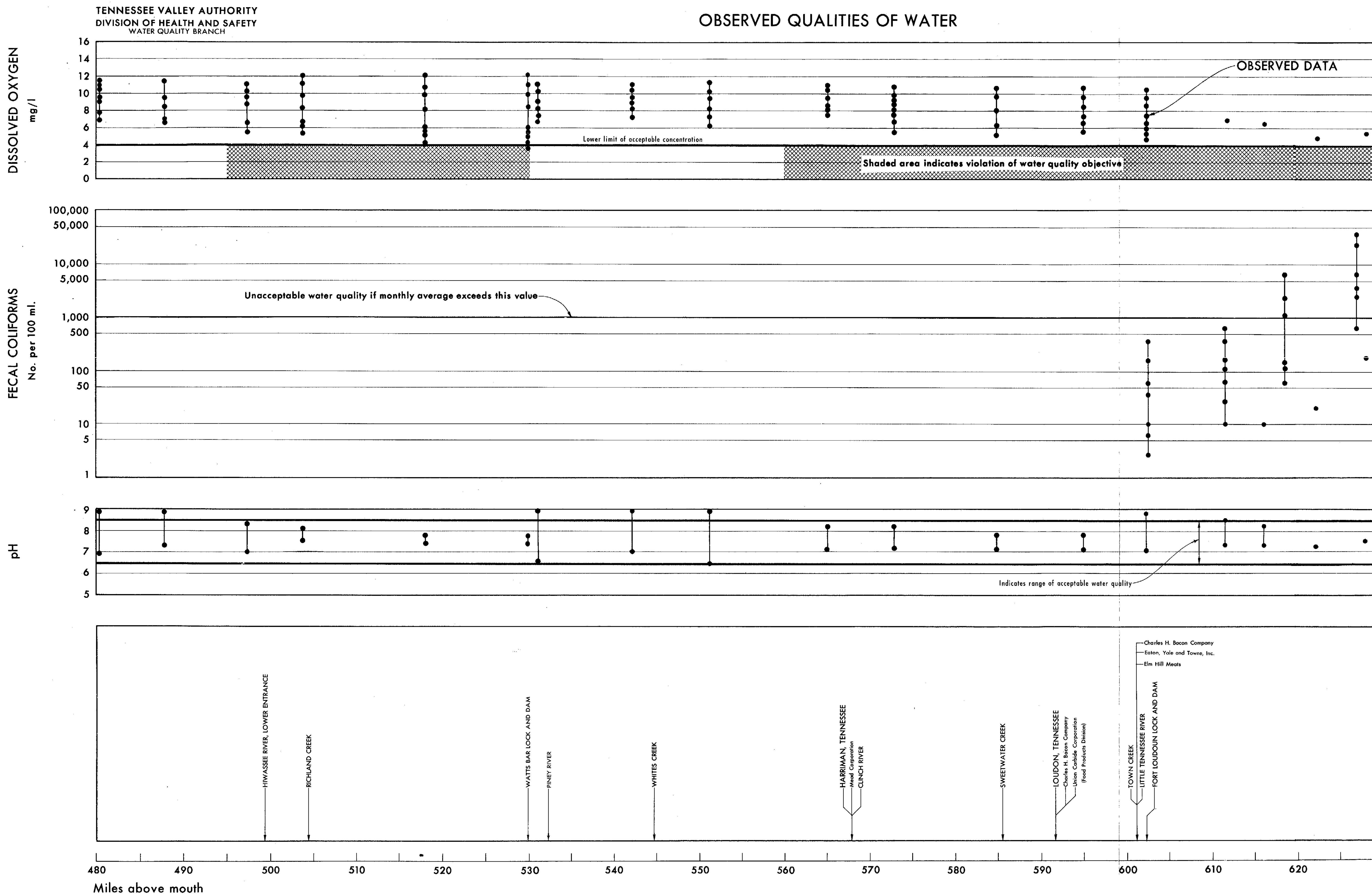
THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN KNOXVILLE, TENNESSEE AND CHICKAMAUGA DAM

SCALE OF MILES

10 0 10 20

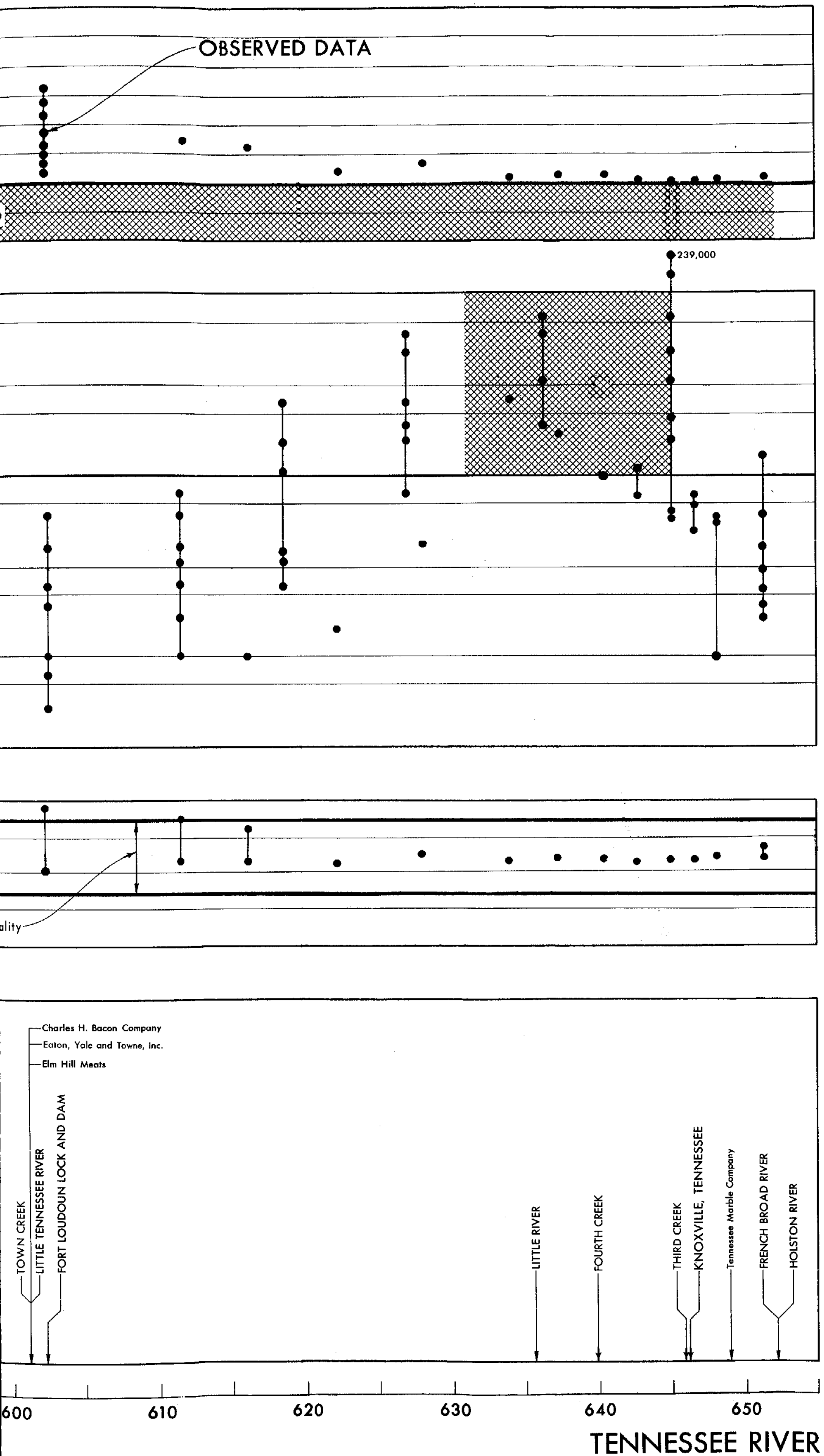
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969

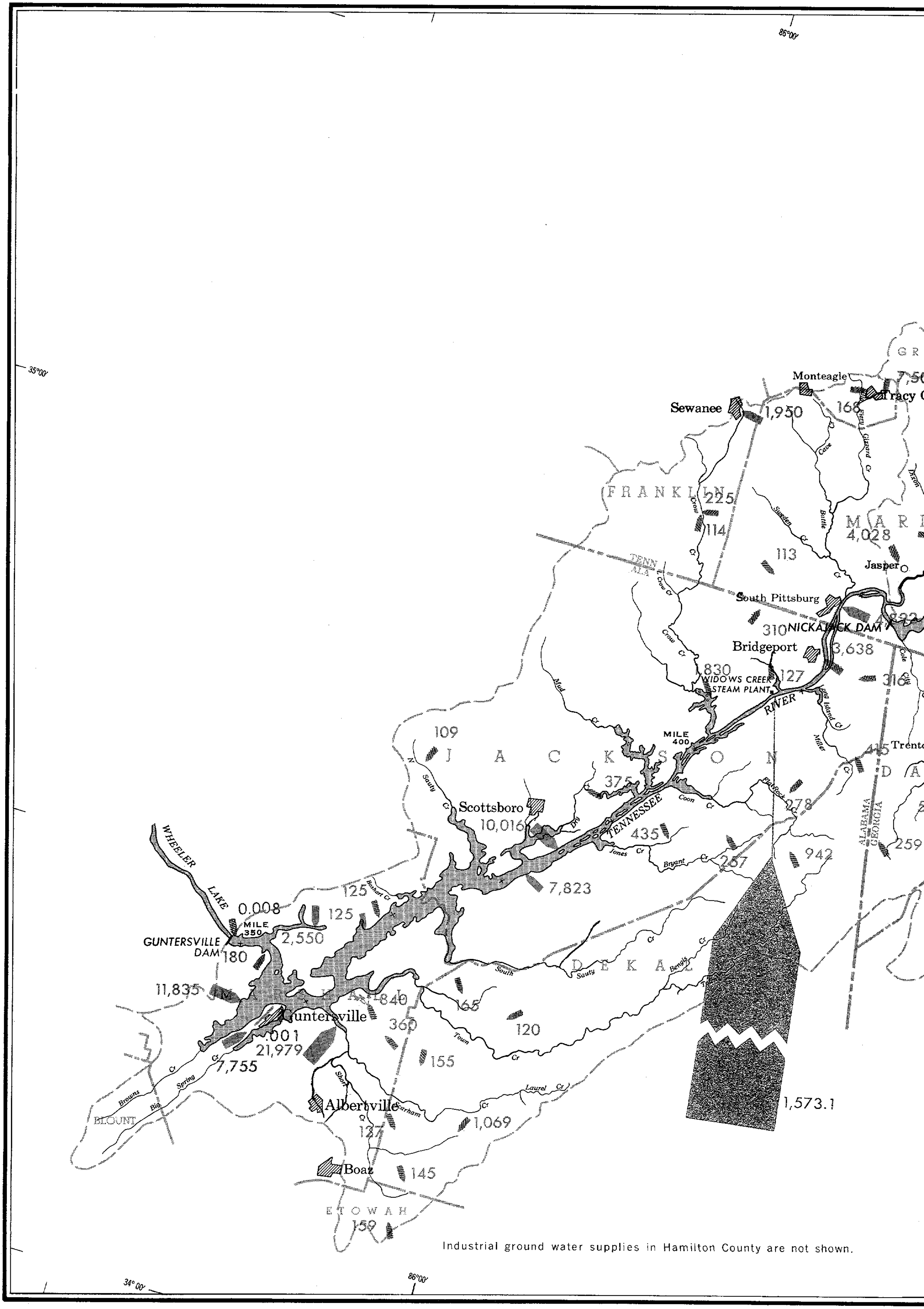


TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
OBSERVED QUALITIES OF WATER
DISSOLVED OXYGEN
mg/l
16
14
12
10
8
6
4
2
0
OBSERVED DATA
Lower limit of acceptable concentration
Shaded area indicates violation of water quality objective
FECAL COLIFORMS
No. per 100 ml.
100,000
50,000
10,000
5,000
1,000
500
100
50
10
5
1
Unacceptable water quality if monthly average exceeds this value
pH
9
8
7
6
5
Indicates range of acceptable water quality
HIWASSEE RIVER, LOWER ENTRANCE
RICHLAND CREEK
WATTS BAR LOCK AND DAM
PINEY RIVER
WHITES CREEK
HARRIMAN, TENNESSEE
Mead Corporation
CLINCH RIVER
SWEETWATER CREEK
LOUDON, TENNESSEE
Charles H. Bacon Company
Union Carbide Corporation
(Food Products Division)
TOWN CREEK
LITTLE TENNESSEE RIVER
FORT LOUDOUN LOCK AND DAM
Charles H. Bacon Company
Eaton, Yale and Towne, Inc.
Elm Hill Meats
480
490
500
510
520
530
540
550
560
570
580
590
600
610
620
Miles above mouth

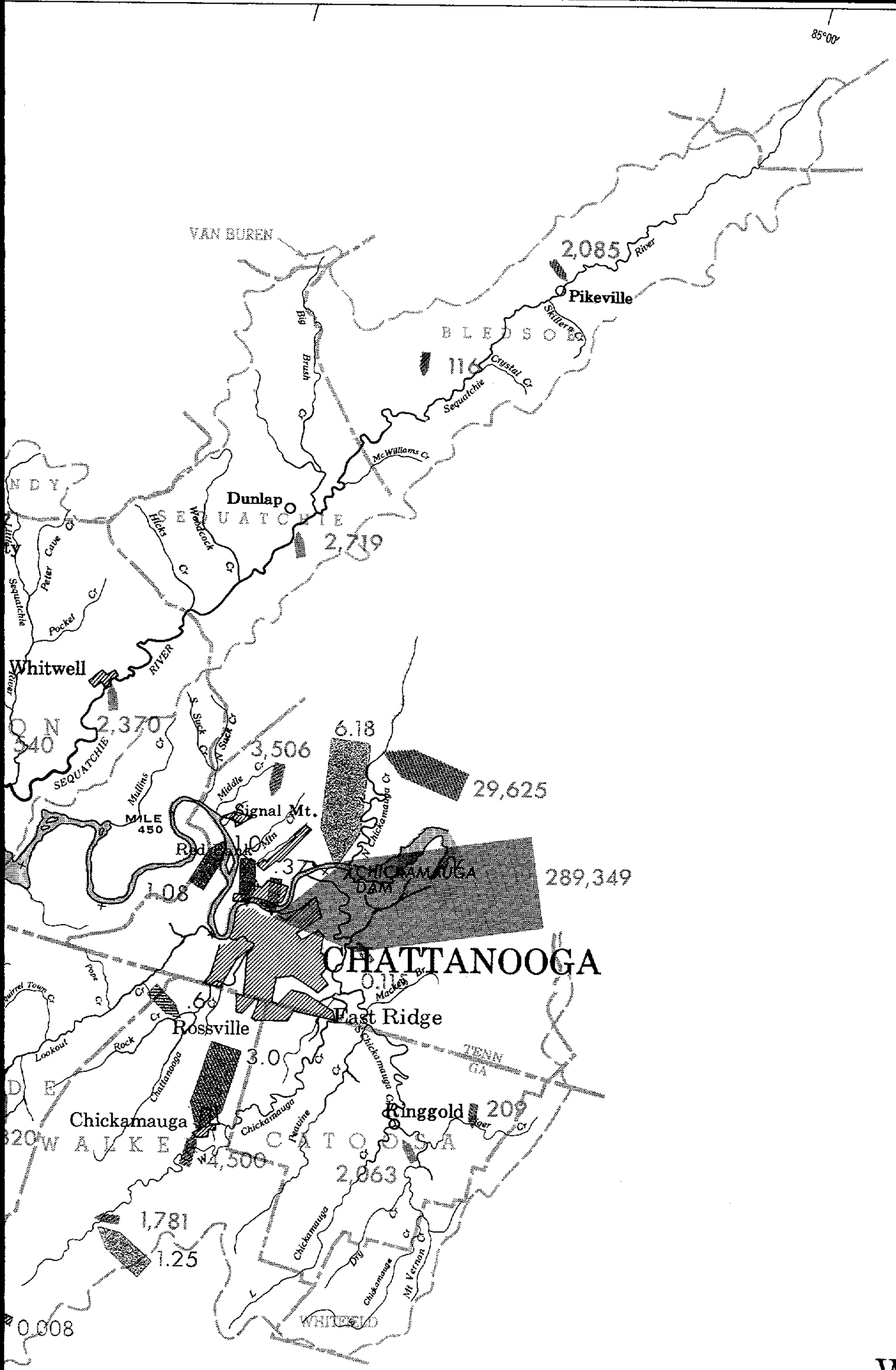
FIGURE IX-3

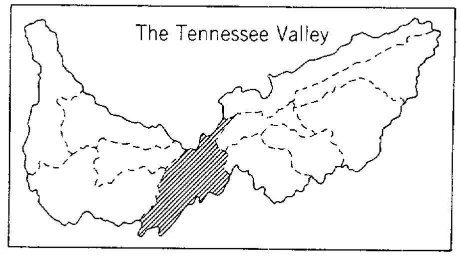

OBSERVED DATA
239,000
ality
Charles H. Bacon Company
Eaton, Yale and Towne, Inc.
Elm Hill Meats
TOWN CREEK
LITTLE TENNESSEE RIVER
FORT LOUDOUN LOCK AND DAM
LITTLE RIVER
FOURTH CREEK
THIRD CREEK
KNOXVILLE, TENNESSEE
Tennessee Marble Company
FRENCH BROAD RIVER
HOLSTON RIVER
600
610
620
630
640
650
TENNESSEE RIVER

THE LOCAL AREA DRAINING TO THE
TENNESSEE RIVER BETWEEN
CHICKAMAUGA DAM AND GUNTERSVILLE DAM



85°00'
35°00'
34° 00'
86°00'
Monteagle
Tracy C
Sewanee
1,950
168
FRANKLIN
225
114
113
MARI
4,028
Jasper
TENN
ALA
South Pittsburg
310
NICKAJACK DAM
Bridgeport
3,638
830
WIDOWS CREEK STEAM PLANT
127
316
RIVER
MILE 400
109
JACKSON
375
Scottsboro
10,016
TENNESSEE
435
278
942
259
7,823
257
WHEELER LAKE
0.008
MILE 350
GUNTERSVILLE DAM
180
2,550
125
125
11,835
MARSHALL
Guntersville
.001
21,979
840
360
165
120
7,755
155
DEKALB
Albertville
127
1,069
Boaz
145
BLOUNT
ETOWAH
159
1,573.1
ALABAMA
GEORGIA
Trenton
Industrial ground water supplies in Hamilton County are not shown.





LOCATION MAP

Figure X-1

WATER SUPPLIES

THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN CHICKAMAUGA DAM AND GUNTERSVILLE DAM

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

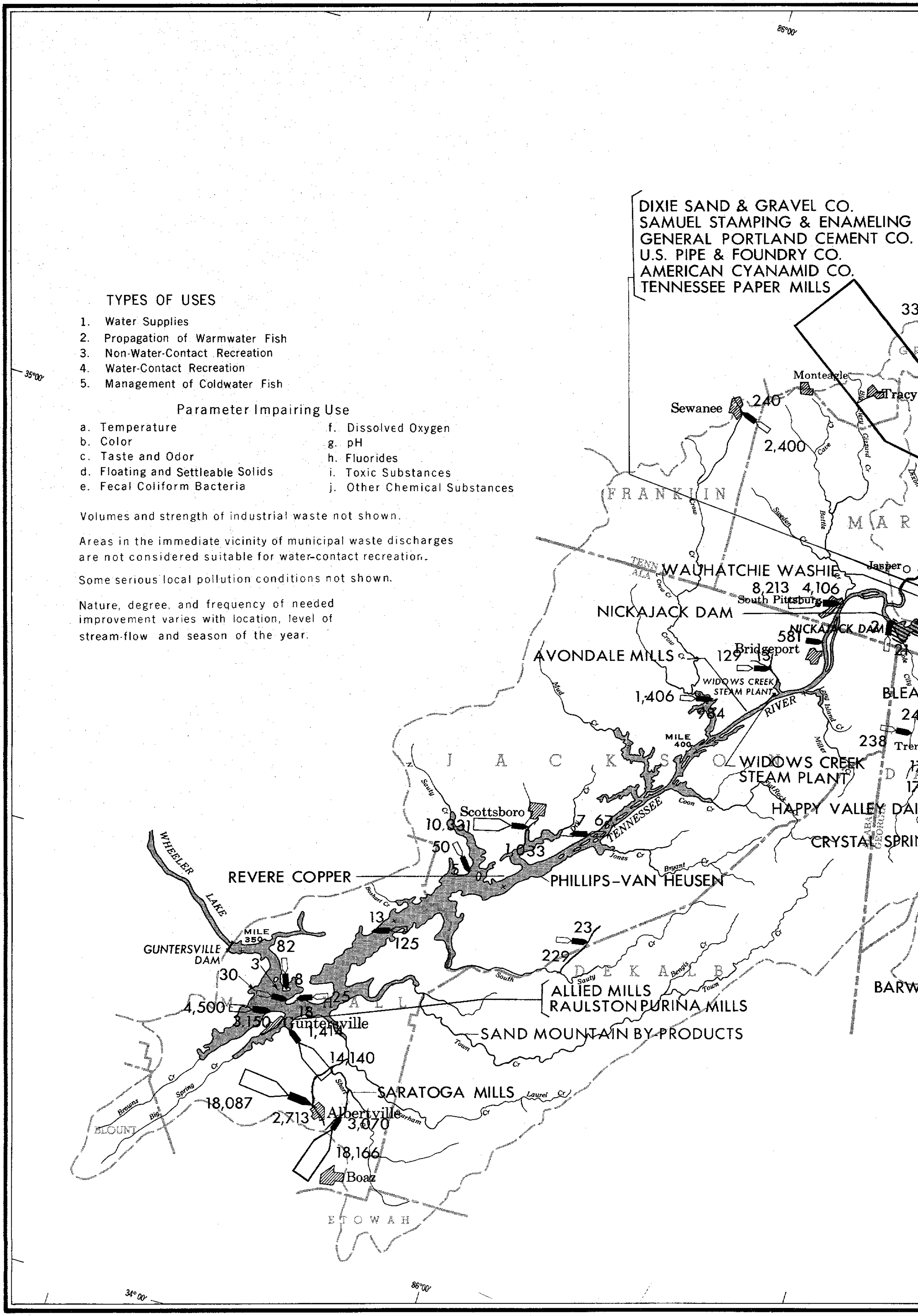
JANUARY 1969

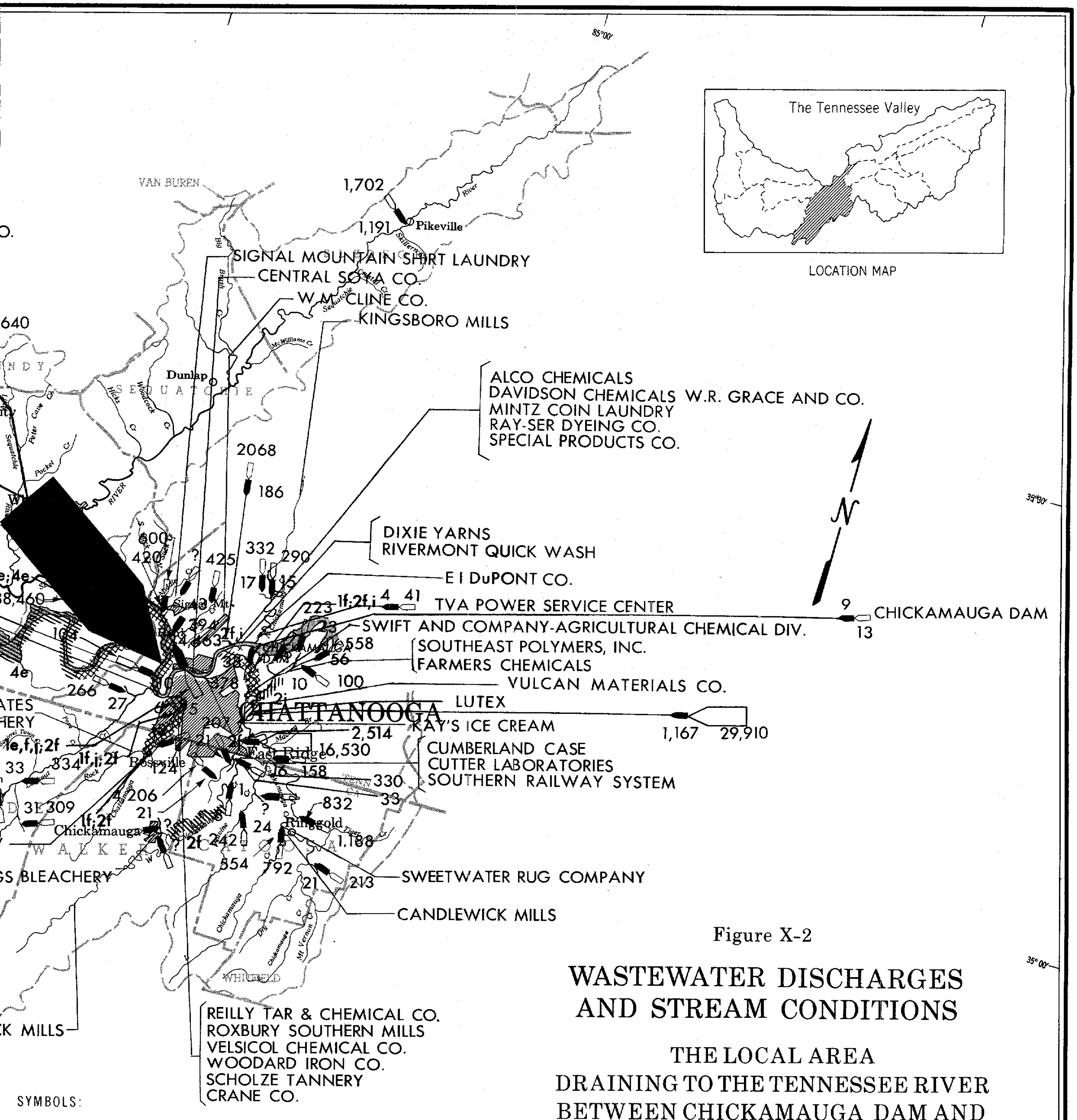
YMBOLS:

- Municipal surface water supplies. Number indicates population served.
- Municipal ground water supplies. Number indicates population served.
- Industrial surface water supplies. Number indicates daily usage in million gallons.
- Industrial ground water supplies. Number indicates daily usage in million gallons.

rea of symbols is proportionate to the daily usage in million gallons or opulation served for those values in the range of 0.2-50 or 2,000-500,000 espectively.

unicipal water supplies serving populations less than 100 are not shown.


TYPES OF USES
1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish
Parameter Impairing Use
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances
Volumes and strength of industrial waste not shown.
Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.
Some serious local pollution conditions not shown.
Nature, degree, and frequency of needed improvement varies with location, level of stream-flow and season of the year.
DIXIE SAND & GRAVEL CO.
SAMUEL STAMPING & ENAMELING
GENERAL PORTLAND CEMENT CO.
U.S. PIPE & FOUNDRY CO.
AMERICAN CYANAMID CO.
TENNESSEE PAPER MILLS
86°00'
35°00'
34°00'
Monteagle
Tracy
Sewanee
240
2,400
FRANKLIN
MAR
Jasper
WAUHATCHIE WASHIE
8,213 4,106
South Pittsburg
NICKAJACK DAM
581
Bridgeport
AVONDALE MILLS
129
WIDOWS CREEK STEAM PLANT
1,406
984
RIVER
MILE 400
238
WIDOWS CREEK STEAM PLANT
JACKSON
HAPPY VALLEY DAI
CRYSTAL SPRIN
Scottsboro
10,931
50
1,033
TENNESSEE
WHEELER LAKE
REVERE COPPER
PHILLIPS-VAN HEUSEN
13
125
23
229
MILE 350
GUNTERSVILLE DAM
82
30
4,500
3,150
Guntersville
1,414
DEKALB
ALLIED MILLS
RAULSTON PURINA MILLS
SAND MOUNTAIN BY-PRODUCTS
14,140
SARATOGA MILLS
18,087
2,713
Albertville
3,070
18,166
Boaz
BLOUNT
ETOWAH
BARW



SYMBOLS:

Sewage pollution.
Number indicates population equivalent of BOD released to stream.

Sewered population.
Number indicates population equivalent of BOD before treatment.

Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.

Satisfactory water quality

Water needing improvement for one type of use

Water needing improvement for two types of uses

Water needing improvement for three or more types of uses

Figure X-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

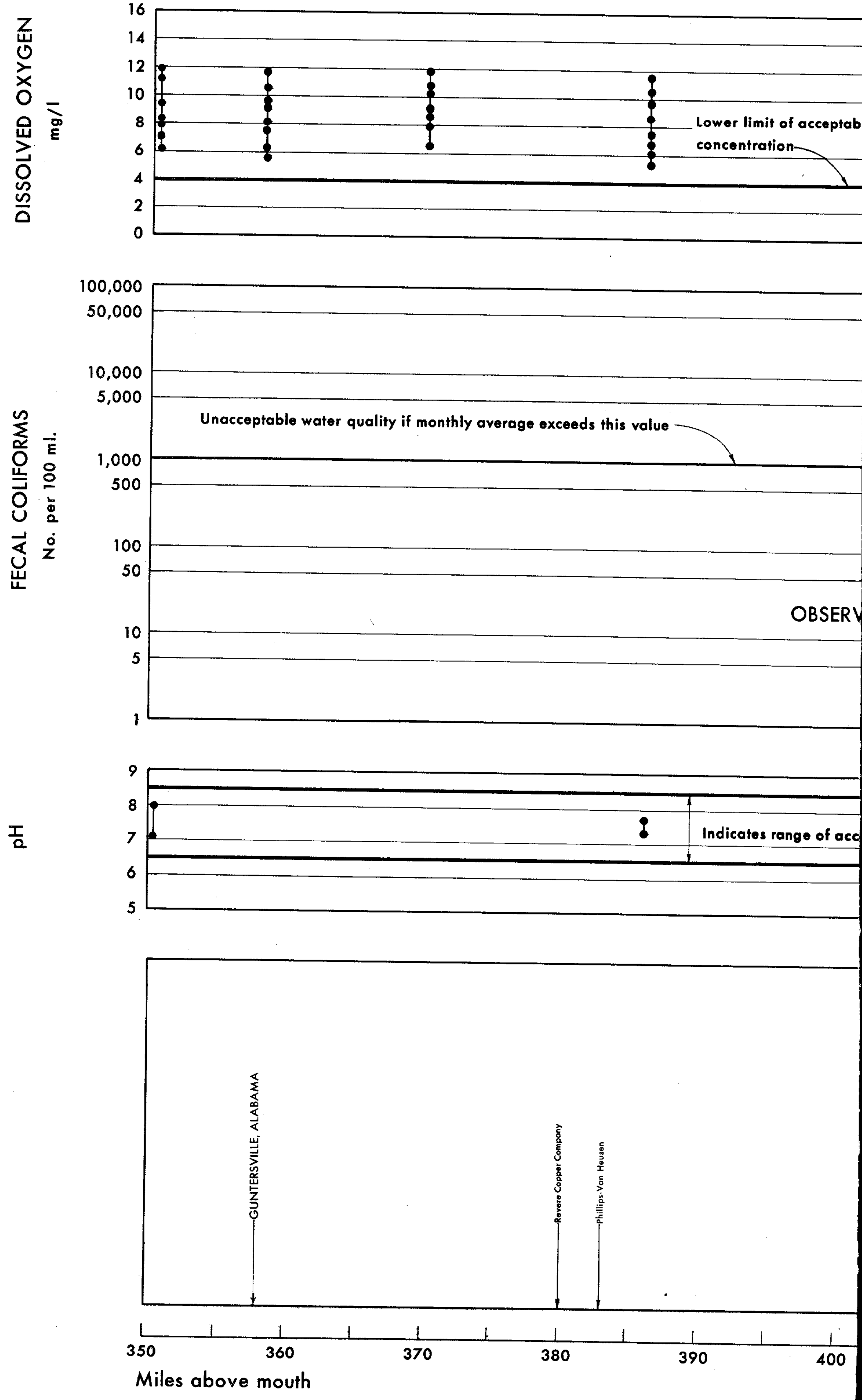
THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN CHICKAMAUGA DAM AND GUNTERSVILLE DAM

SCALE OF MILES

10 0 10 20

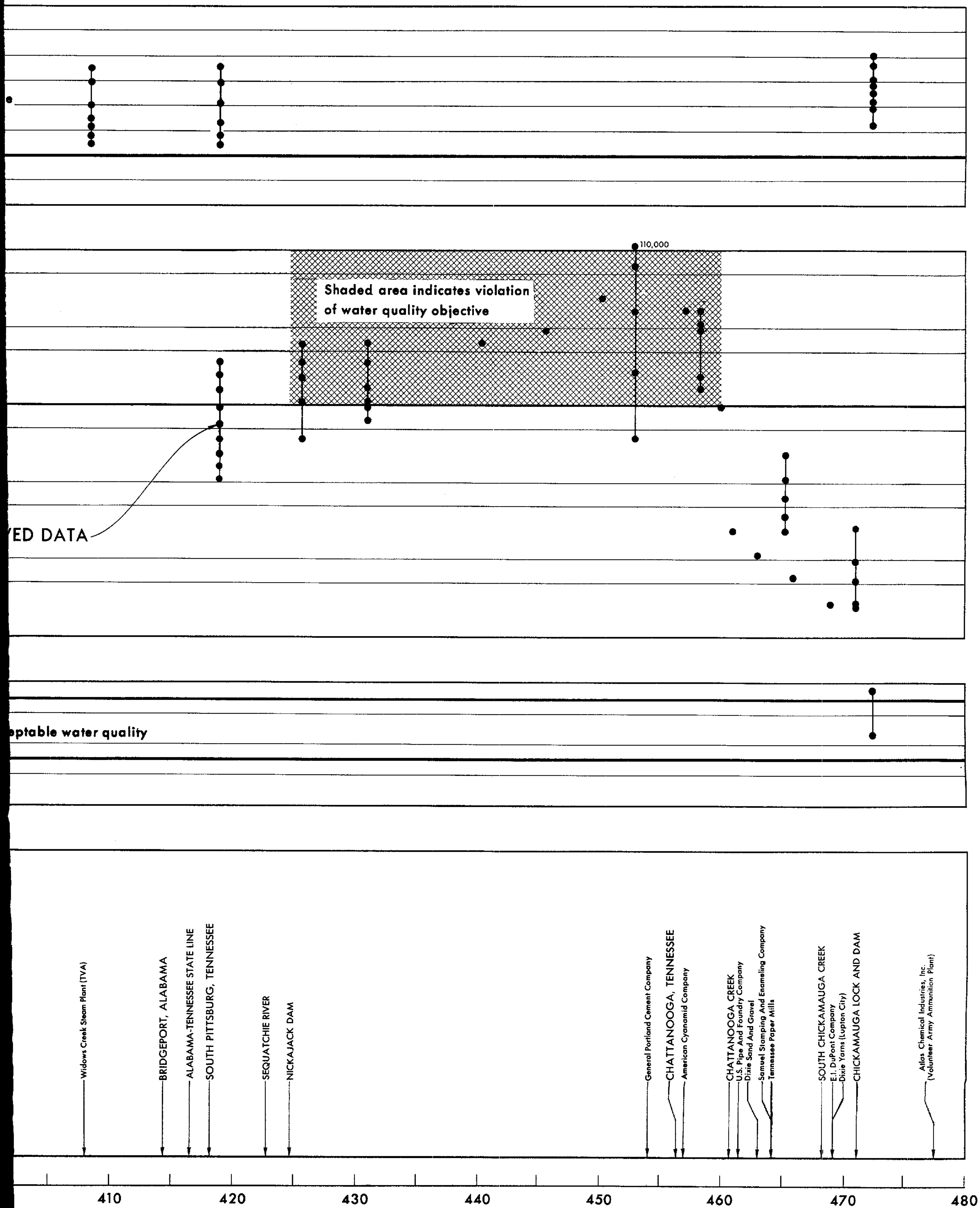
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

JANUARY 1969


DISSOLVED OXYGEN
mg/l
16
14
12
10
8
6
4
2
0
Lower limit of acceptab
concentration
FECAL COLIFORMS
No. per 100 ml.
100,000
50,000
10,000
5,000
1,000
500
100
50
10
5
1
Unacceptable water quality if monthly average exceeds this value
OBSERV
pH
9
8
7
6
5
Indicates range of acc
GUNTERSVILLE, ALABAMA
Revere Copper Company
Phillips-Van Heusen
350
360
370
380
390
400
Miles above mouth

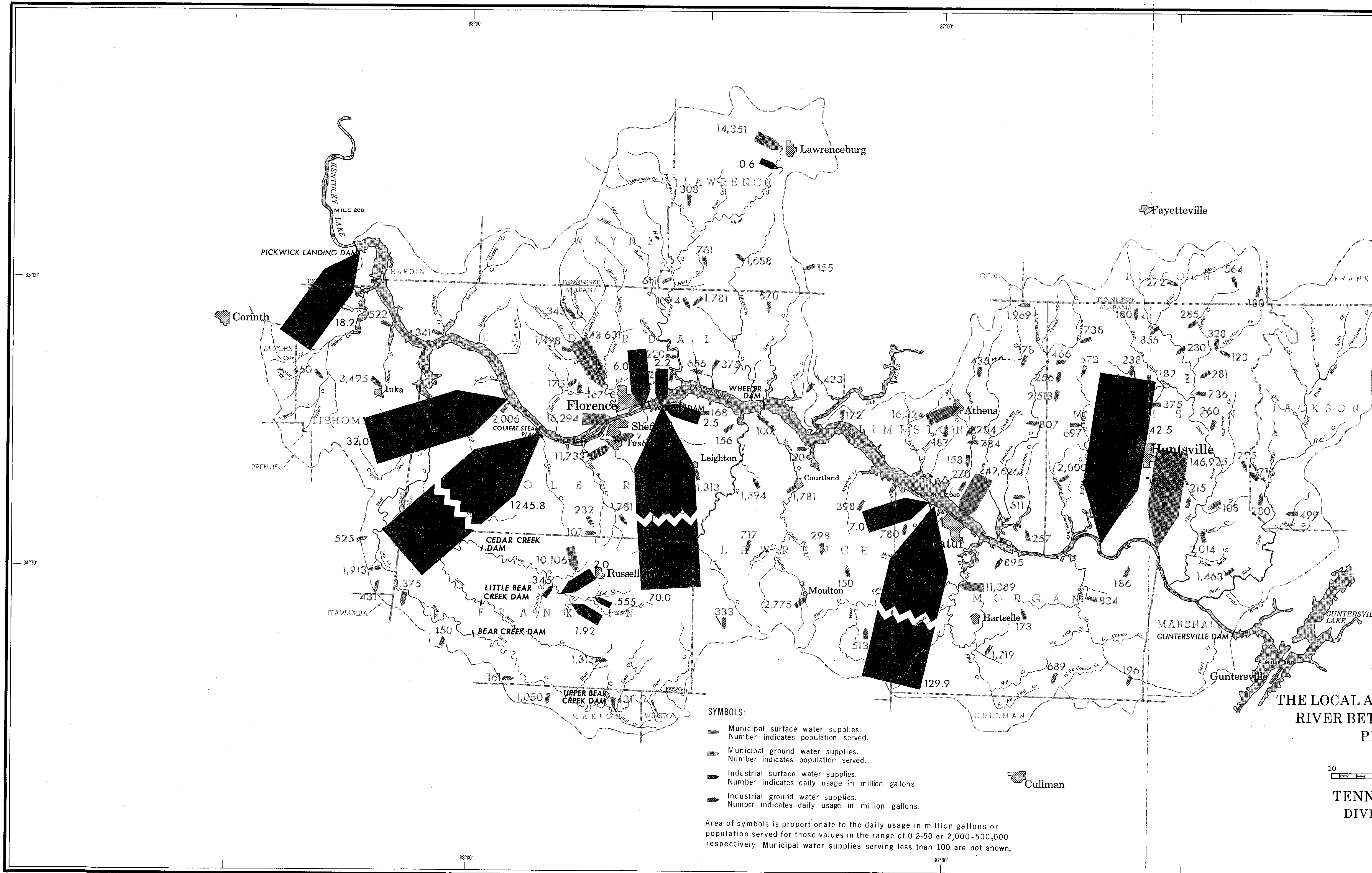
OBSERVED QUALITIES OF WATER

FIGURE X-3



TENNESSEE RIVER

THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN GUNTERSVILLE DAM AND PICKWICK DAM


THE LOCAL A
RIVER BET
P
TENN
DIVI
KENTUCKY LAKE
MILE 200
PICKWICK LANDING DAM
COLBERT STEAM PLANT
WHEELER DAM
GUNTERSVILLE DAM
GUNTERSVILLE LAKE
CEDAR CREEK DAM
LITTLE BEAR CREEK DAM
BEAR CREEK DAM
UPPER BEAR CREEK DAM
TENNESSEE RIVER
Corinth
Iuka
Lawrenceburg
Fayetteville
Florence
Russellville
Leighton
Courtland
Moulton
Athens
Hartselle
Huntsville
Guntersville
Cullman
HARDIN
WAYNE
LAWRENCE
LAUDERDALE
COLBERT
FRANKLIN
MARION
WINSTON
TISHOMINGO
ALCORN
PRENTISS
ITAWAMBA
LIMESTONE
MORGAN
CULLMAN
MADISON
MARSHALL
JACKSON
LINCOLN
GILES
FRANKLIN
TENNESSEE
ALABAMA
SYMBOLS:
Municipal surface water supplies. Number indicates population served.
Municipal ground water supplies. Number indicates population served.
Industrial surface water supplies. Number indicates daily usage in million gallons.
Industrial ground water supplies. Number indicates daily usage in million gallons.
Area of symbols is proportionate to the daily usage in million gallons or population served for those values in the range of 0.2-50 or 2,000-500,000 respectively. Municipal water supplies serving less than 100 are not shown.

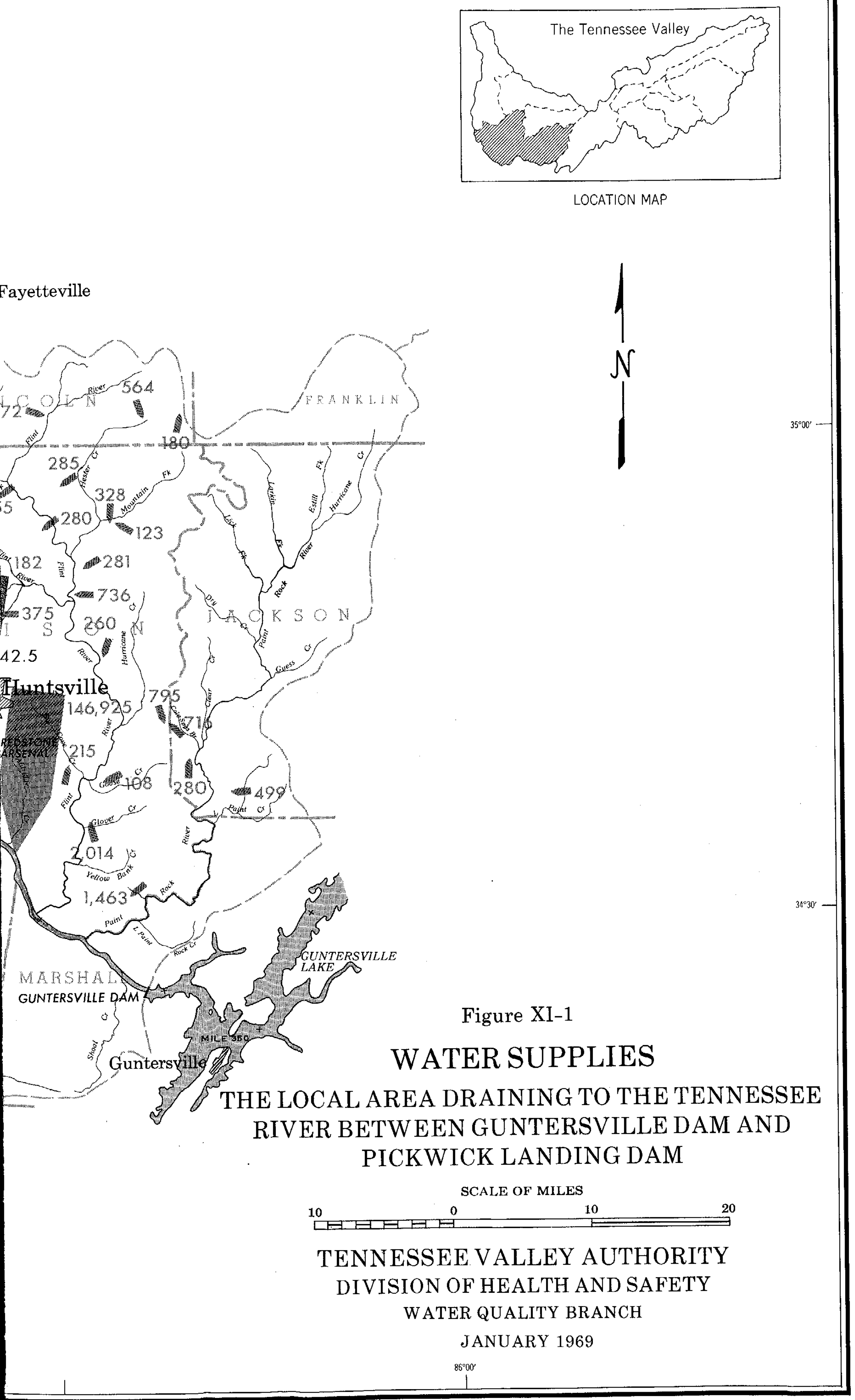


Figure XI-1

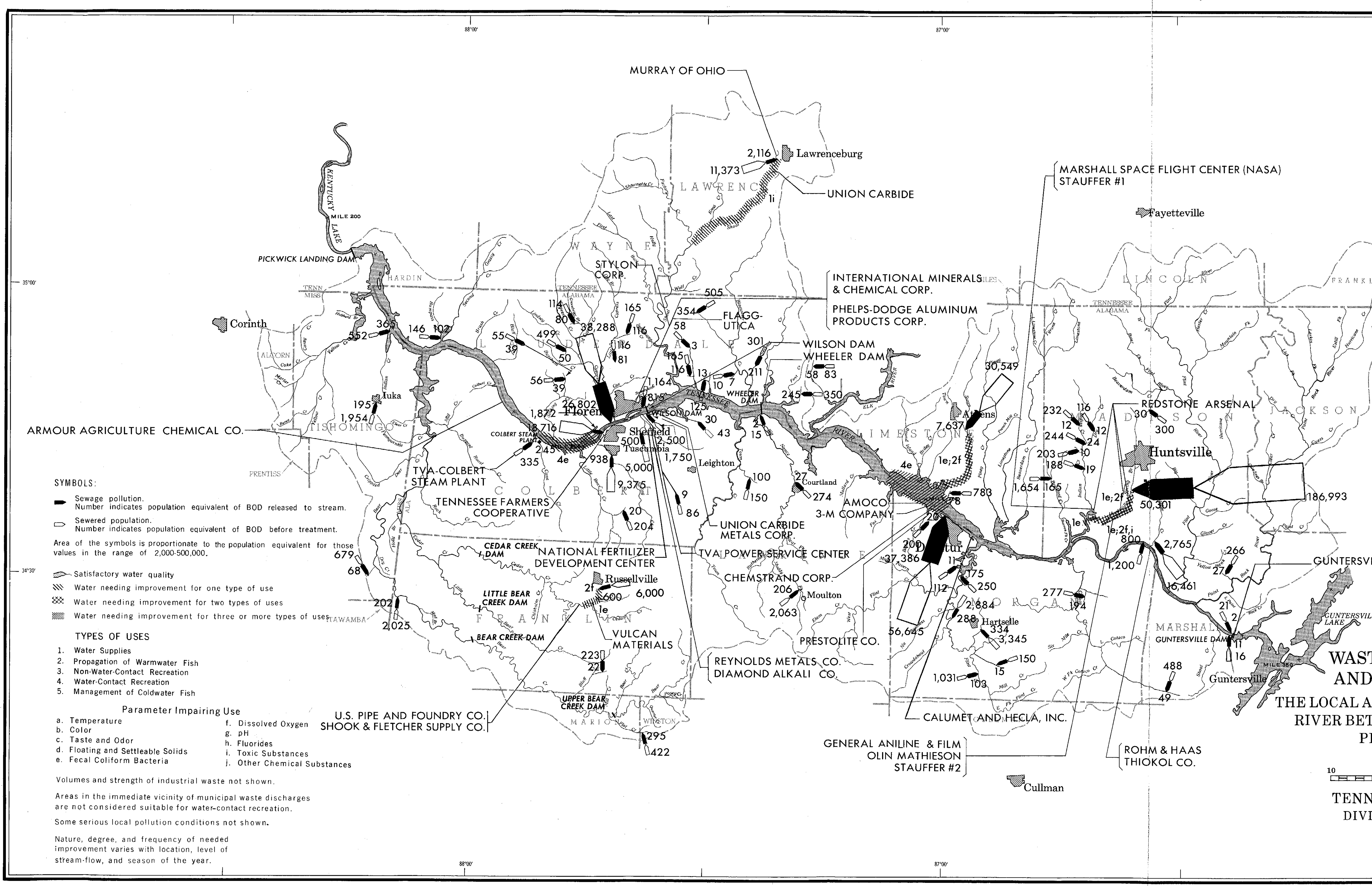
WATER SUPPLIES

THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN GUNTERSVILLE DAM AND PICKWICK LANDING DAM

SCALE OF MILES

10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969



MURRAY OF OHIO
Lawrenceburg
UNION CARBIDE
MARSHALL SPACE FLIGHT CENTER (NASA)
STAUFFER #1
Fayetteville
KENTUCKY LAKE
MILE 200
PICKWICK LANDING DAM
STYLON CORP.
INTERNATIONAL MINERALS & CHEMICAL CORP.
PHELPS-DODGE ALUMINUM PRODUCTS CORP.
FLAGG-UTICA
WILSON DAM
WHEELER DAM
Corinth
Iuka
ARMOUR AGRICULTURE CHEMICAL CO.
COLBERT STEAM PLANT
TVA-COLBERT STEAM PLANT
TENNESSEE FARMERS COOPERATIVE
Florence
Sheffield
Tuscumbia
Leighton
Courtland
Athens
Huntsville
Decatur
REDSTONE ARSENAL
AMOCO
3-M COMPANY
UNION CARBIDE METALS CORP.
NATIONAL FERTILIZER DEVELOPMENT CENTER
TVA POWER SERVICE CENTER
CHEMSTRAND CORP.
CEDAR CREEK DAM
LITTLE BEAR CREEK DAM
BEAR CREEK DAM
UPPER BEAR CREEK DAM
Russellville
VULCAN MATERIALS
Moulton
PRESTOLITE CO.
REYNOLDS METALS CO.
DIAMOND ALKALI CO.
Hartselle
U.S. PIPE AND FOUNDRY CO.
SHOOK & FLETCHER SUPPLY CO.
CALUMET AND HECLA, INC.
GENERAL ANILINE & FILM
OLIN MATHIESON
STAUFFER #2
ROHM & HAAS
THIOKOL CO.
Cullman
GUNTERSVILLE DAM
Guntersville
GUNTERSVILLE LAKE
MILE 350
SYMBOLS:
Sewage pollution.
Number indicates population equivalent of BOD released to stream.
Sewered population.
Number indicates population equivalent of BOD before treatment.
Area of the symbols is proportionate to the population equivalent for those values in the range of 2,000-500,000.
Satisfactory water quality
Water needing improvement for one type of use
Water needing improvement for two types of uses
Water needing improvement for three or more types of uses
TYPES OF USES
1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish
Parameter Impairing Use
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances
Volumes and strength of industrial waste not shown.
Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.
Some serious local pollution conditions not shown.
Nature, degree, and frequency of needed improvement varies with location, level of stream-flow, and season of the year.

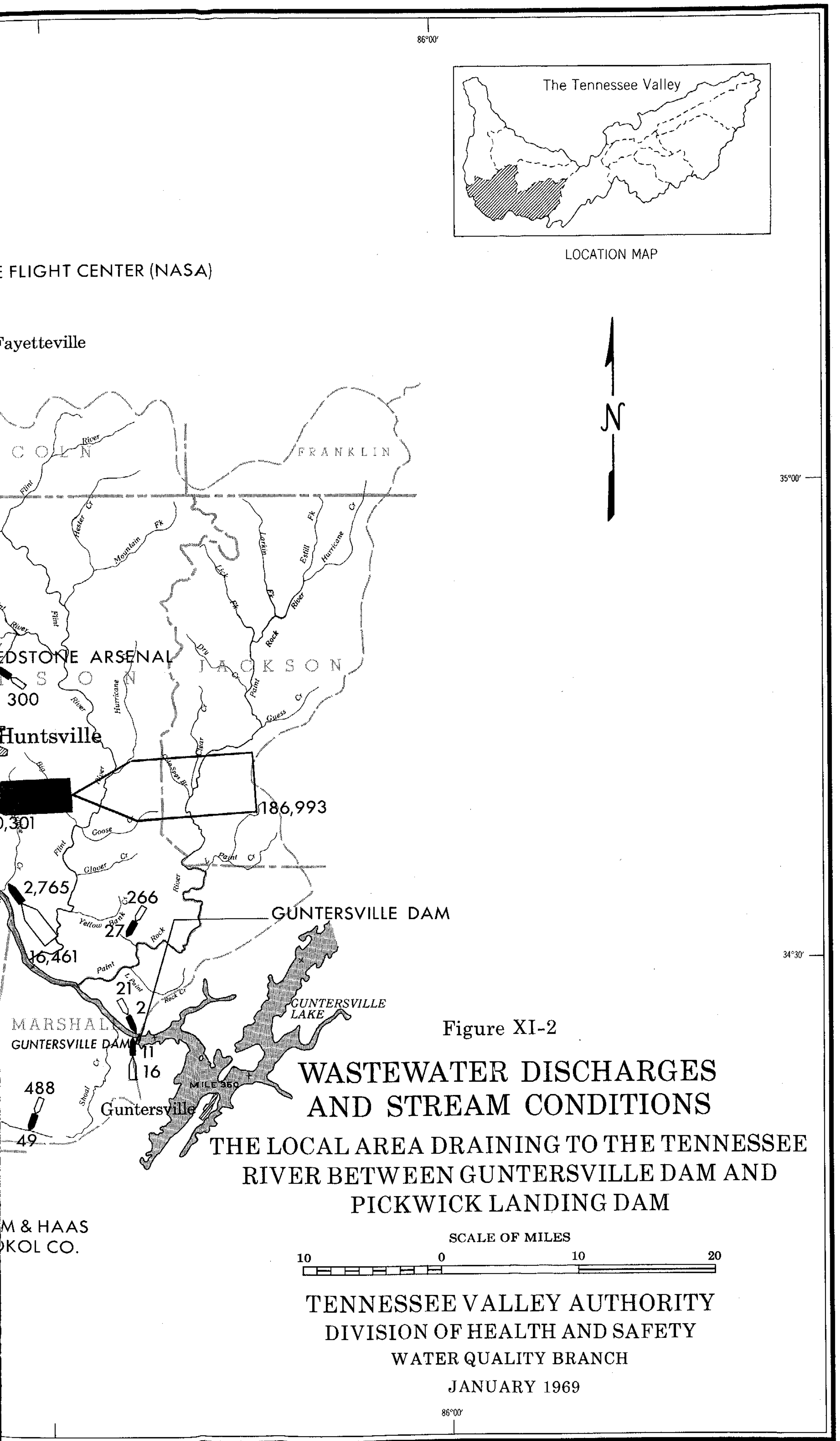


Figure XI-2

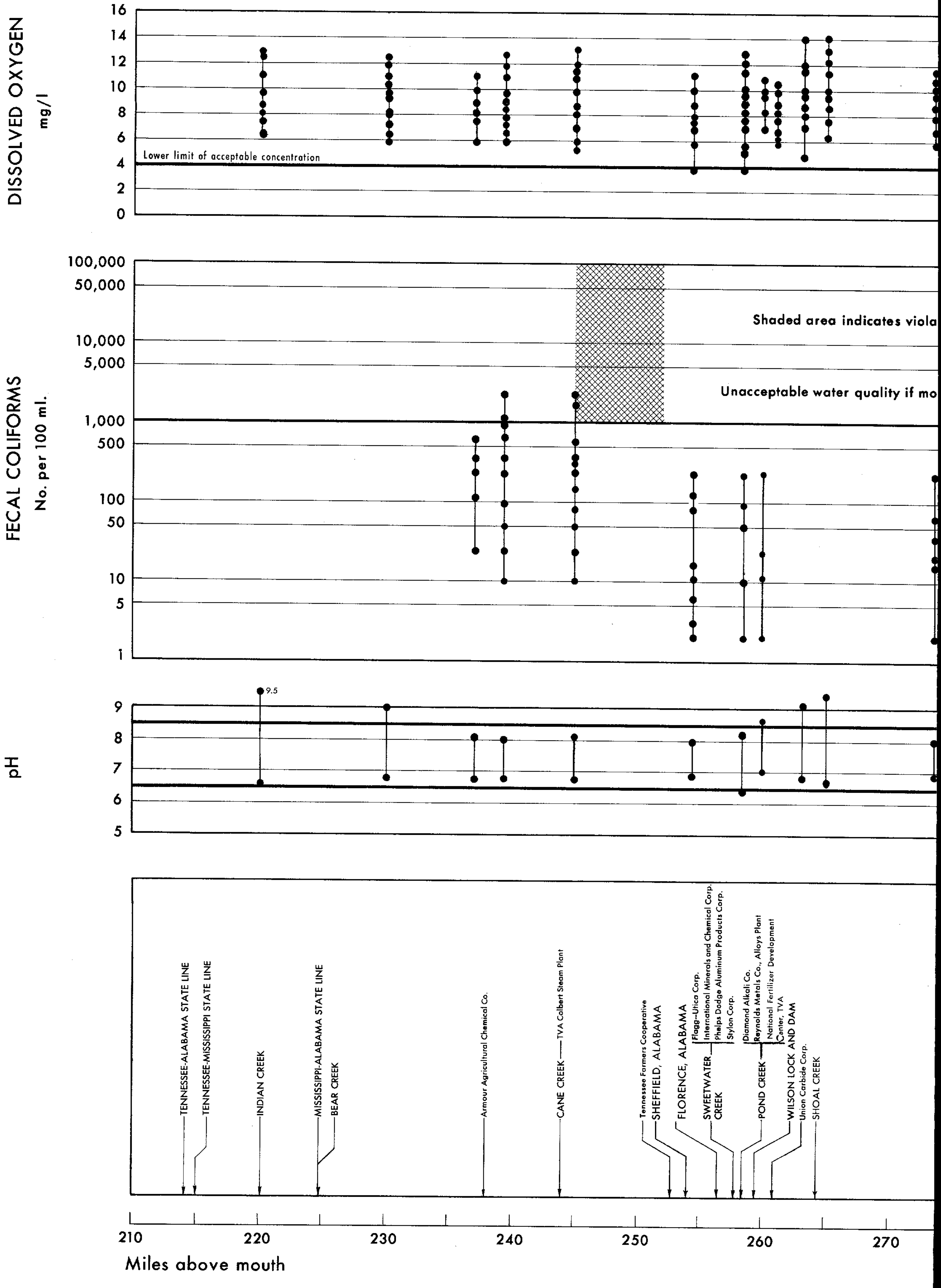
WASTEWATER DISCHARGES AND STREAM CONDITIONS

THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN GUNTERSVILLE DAM AND PICKWICK LANDING DAM

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969

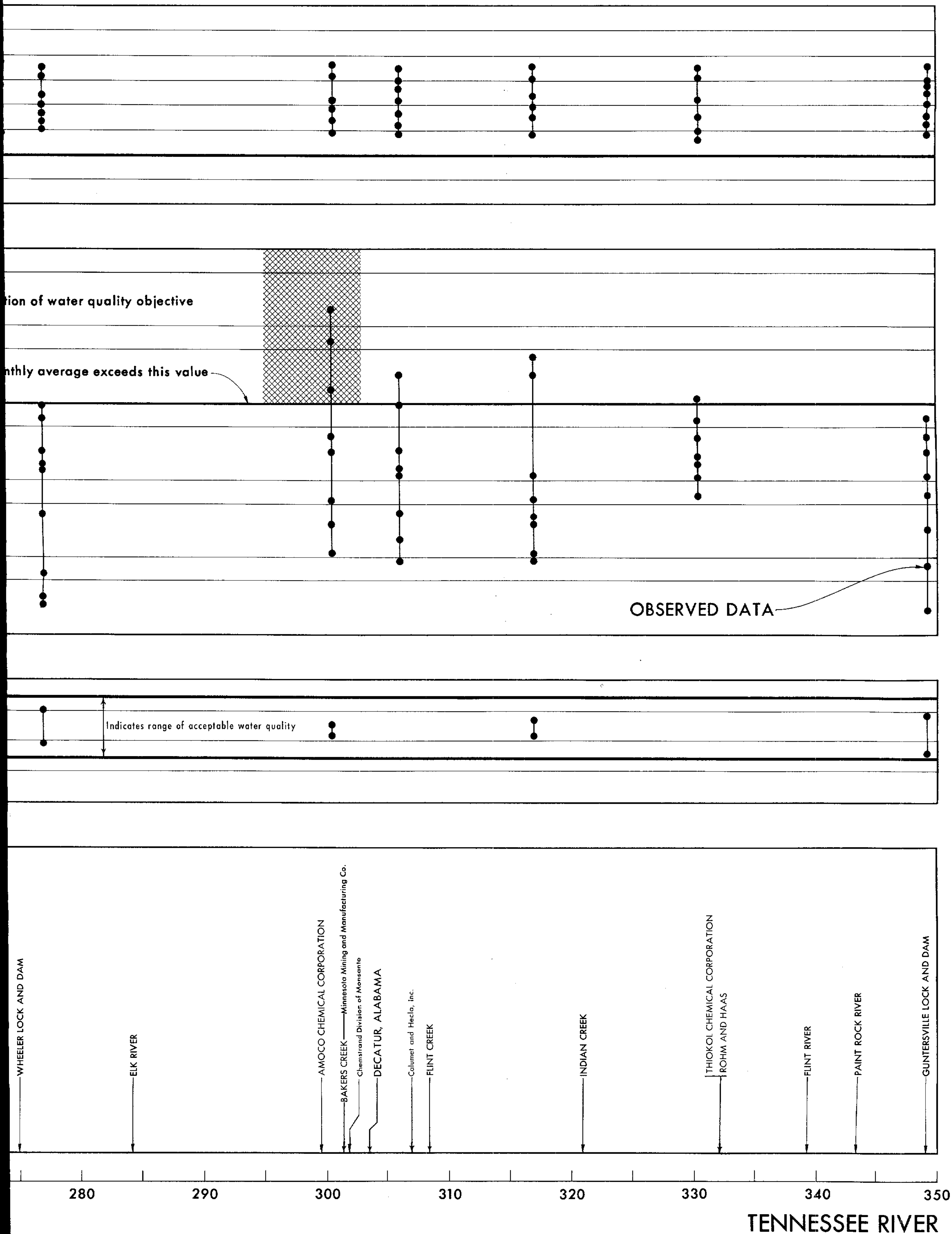
TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED

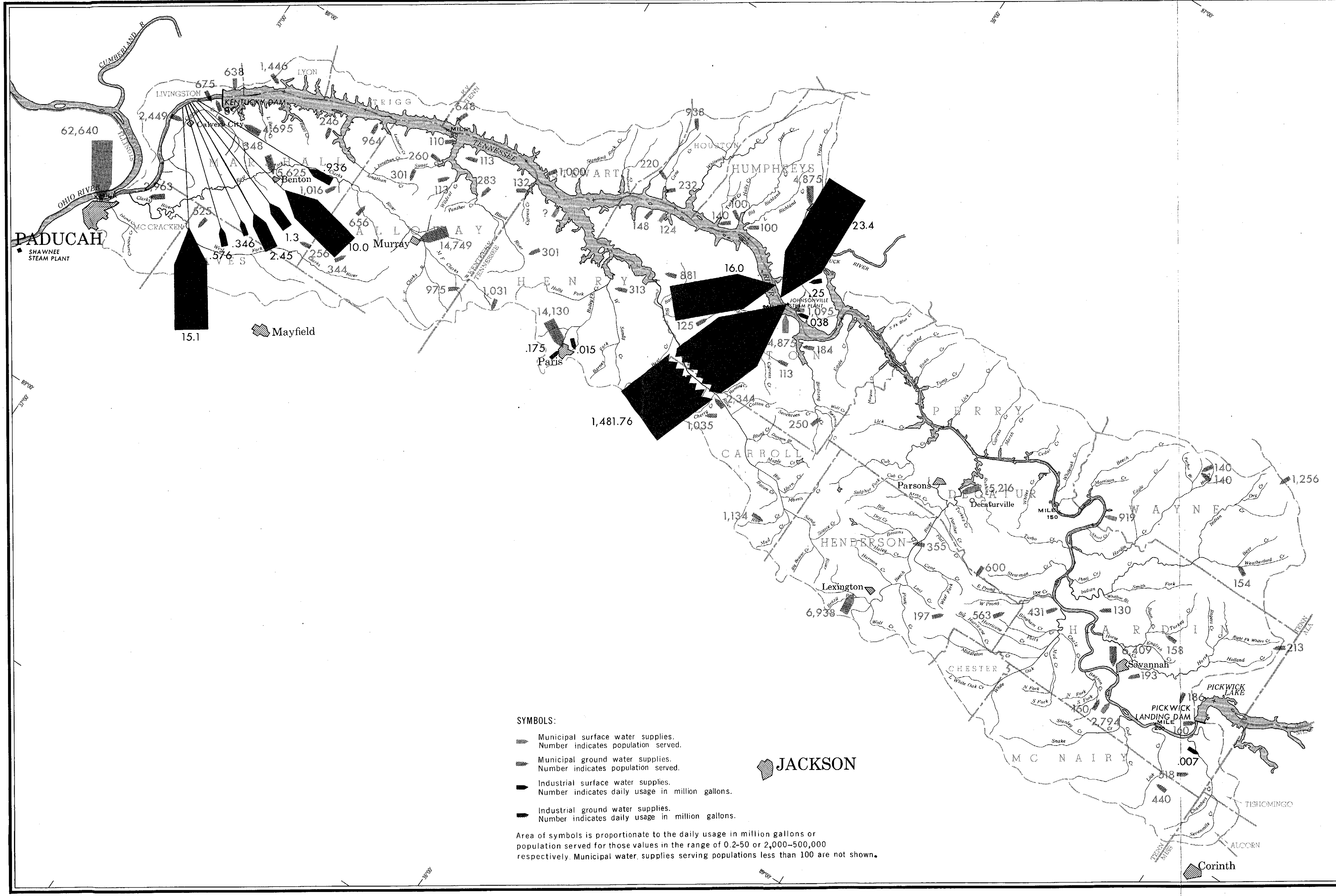


D QUALITIES OF WATER

FIGURE XI-3



THE LOCAL AREA DRAINING TO THE TENNESSEE RIVER BETWEEN PICKWICK DAM AND THE MOUTH



DRAIN
BETW
AND

TENN
DIV

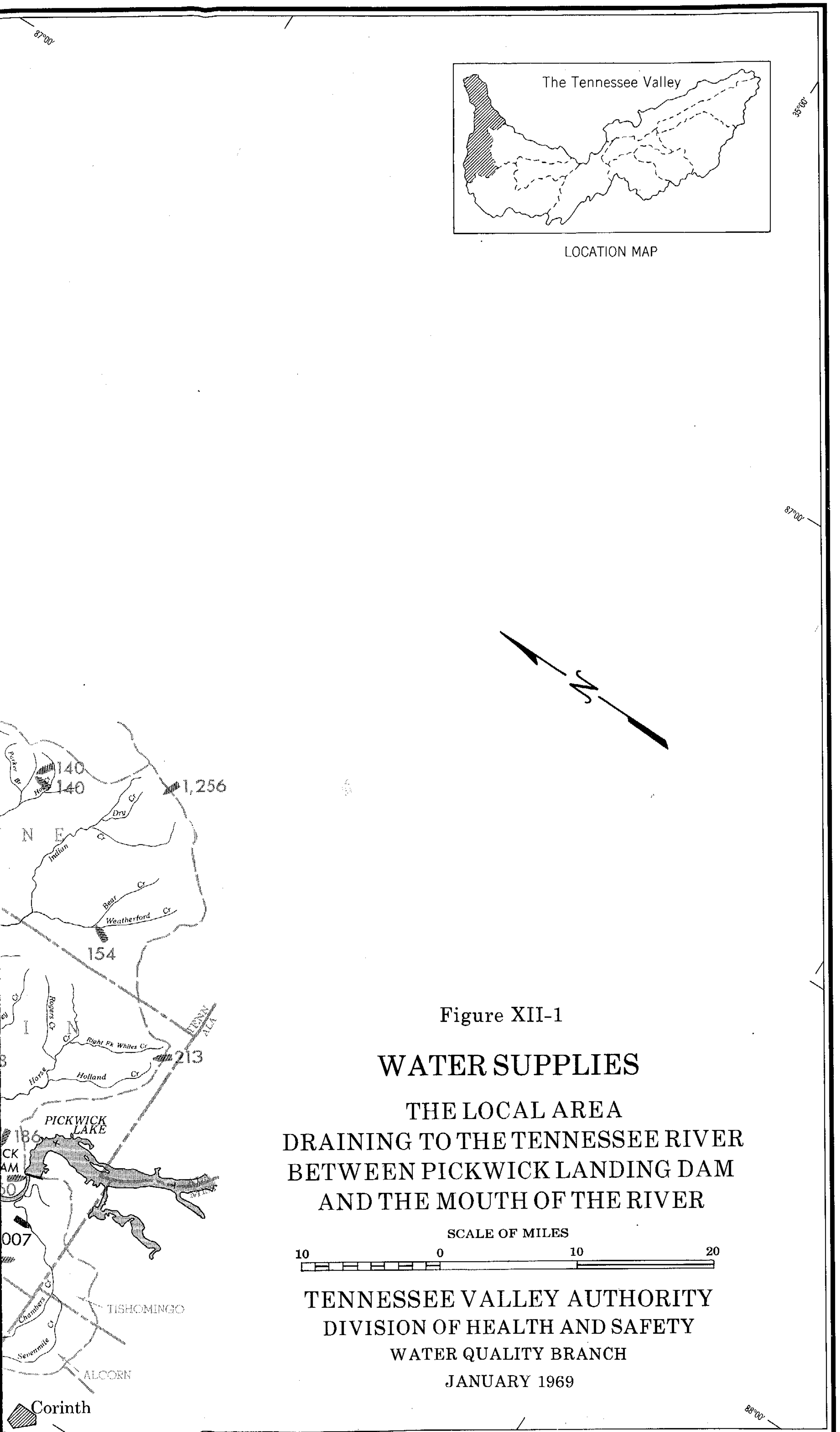


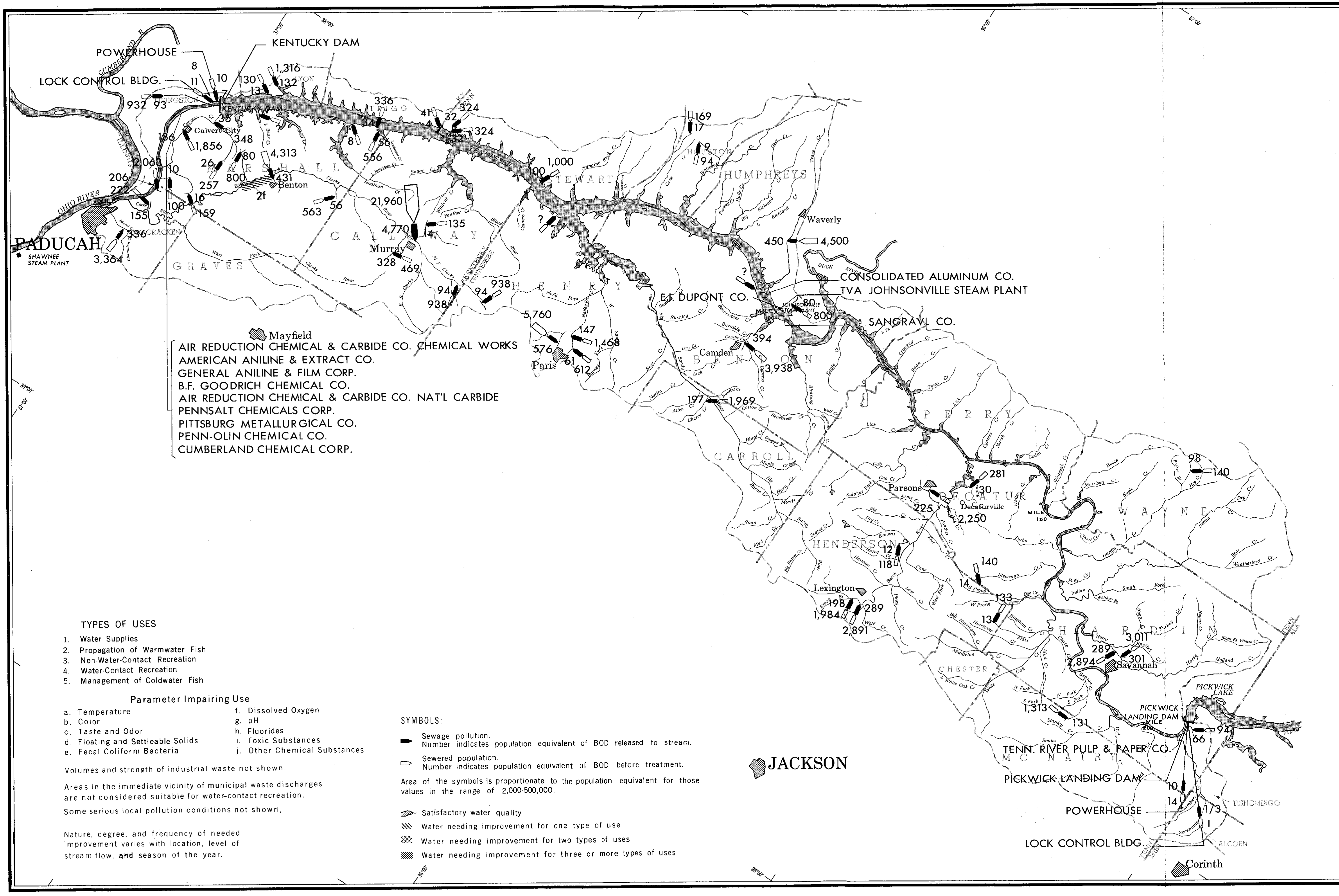
Figure XII-1

WATER SUPPLIES

THE LOCAL AREA
DRAINING TO THE TENNESSEE RIVER
BETWEEN PICKWICK LANDING DAM
AND THE MOUTH OF THE RIVER

SCALE OF MILES
10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969


POWERHOUSE
LOCK CONTROL BLDG.
KENTUCKY DAM
PADUCAH
SHAWNEE STEAM PLANT
OHIO RIVER
Calvert City
Benton
Murray
Mayfield
Paris
Camden
Waverly
Parsons
Decaturville
Lexington
Savannah
Corinth
JACKSON
GRAVES
MARSHALL
CALLOWAY
TRIGG
LYON
STEWART
HOUSTON
HUMPHREYS
HENRY
BENTON
CARROLL
PERRY
DECATUR
HENDERSON
WAYNE
CHESTER
HARDIN
MC NAIRY
TISHOMINGO
ALCORN
PICKWICK LAKE
DUCK RIVER
TENNESSEE RIVER
AIR REDUCTION CHEMICAL & CARBIDE CO. CHEMICAL WORKS
AMERICAN ANILINE & EXTRACT CO.
GENERAL ANILINE & FILM CORP.
B.F. GOODRICH CHEMICAL CO.
AIR REDUCTION CHEMICAL & CARBIDE CO. NAT'L CARBIDE
PENNSALT CHEMICALS CORP.
PITTSBURG METALLURGICAL CO.
PENN-OLIN CHEMICAL CO.
CUMBERLAND CHEMICAL CORP.
E.I. DUPONT CO.
CONSOLIDATED ALUMINUM CO.
TVA JOHNSONVILLE STEAM PLANT
SANGRAVL CO.
TENN. RIVER PULP & PAPER CO.
PICKWICK LANDING DAM
TYPES OF USES
1. Water Supplies
2. Propagation of Warmwater Fish
3. Non-Water-Contact Recreation
4. Water-Contact Recreation
5. Management of Coldwater Fish
Parameter Impairing Use
a. Temperature
b. Color
c. Taste and Odor
d. Floating and Settleable Solids
e. Fecal Coliform Bacteria
f. Dissolved Oxygen
g. pH
h. Fluorides
i. Toxic Substances
j. Other Chemical Substances
Volumes and strength of industrial waste not shown.
Areas in the immediate vicinity of municipal waste discharges are not considered suitable for water-contact recreation.
Some serious local pollution conditions not shown.
Nature, degree, and frequency of needed improvement varies with location, level of stream flow, and season of the year.
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Sewered population. Number indicates population equivalent of BOD before treatment.
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Satisfactory water quality
Water needing improvement for one type of use
Water needing improvement for two types of uses
Water needing improvement for three or more types of uses

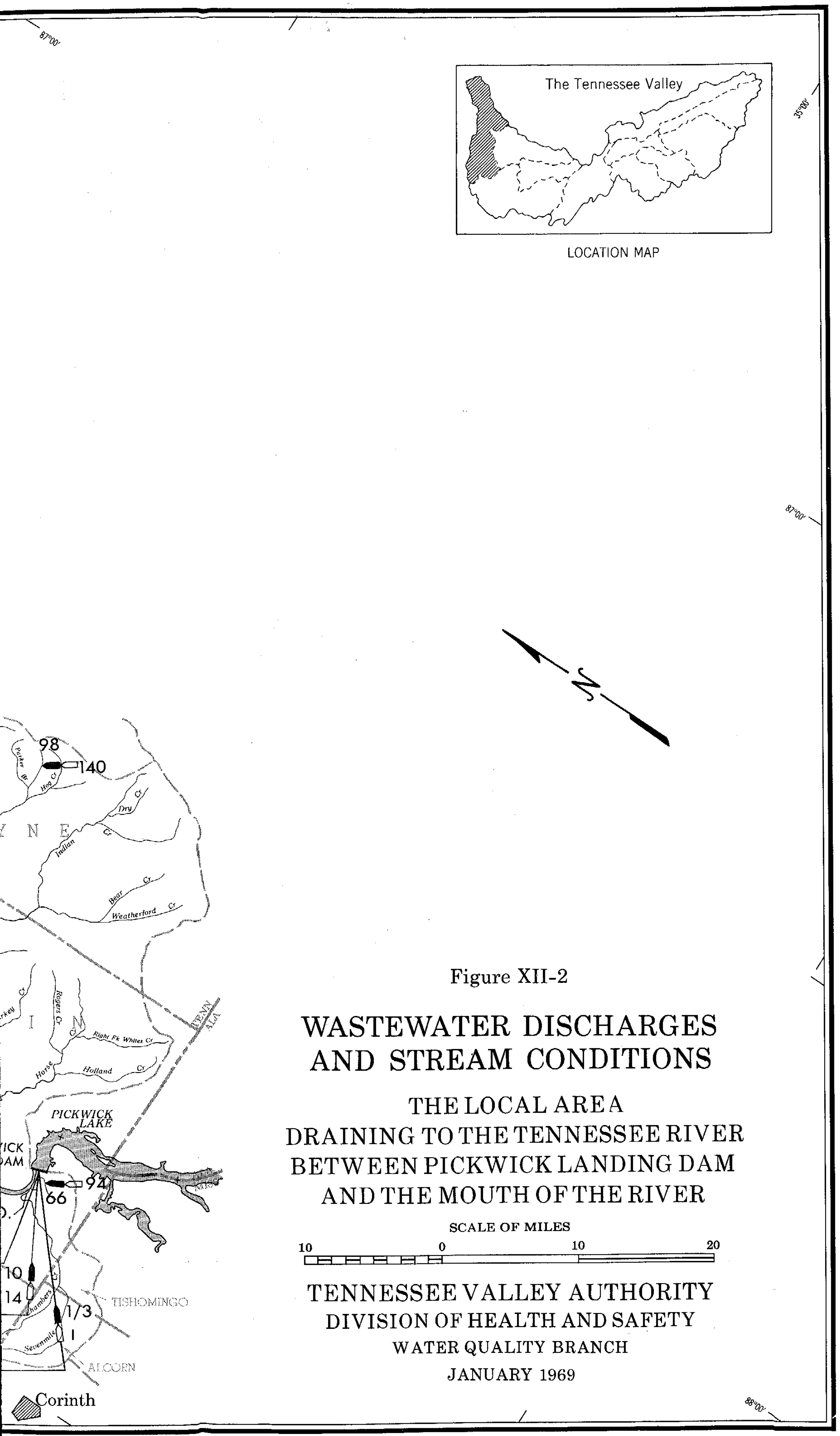


Figure XII-2

WASTEWATER DISCHARGES AND STREAM CONDITIONS

THE LOCAL AREA
DRAINING TO THE TENNESSEE RIVER
BETWEEN PICKWICK LANDING DAM
AND THE MOUTH OF THE RIVER

SCALE OF MILES
10 0 10 20

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH
JANUARY 1969

TENNESSEE VALLEY AUTHORITY
DIVISION OF HEALTH AND SAFETY
WATER QUALITY BRANCH

OBSERVED QUALITIES OF WATER

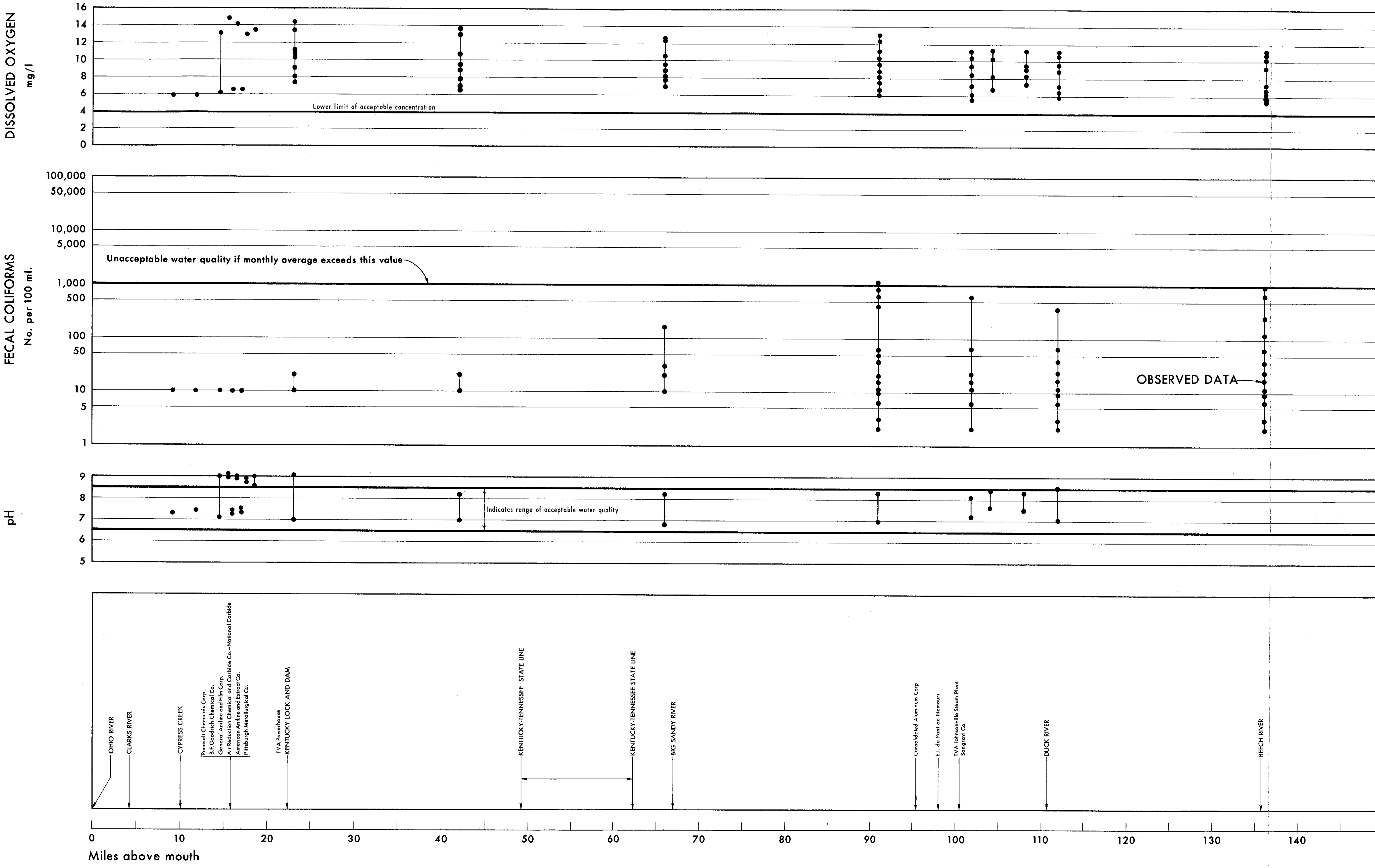
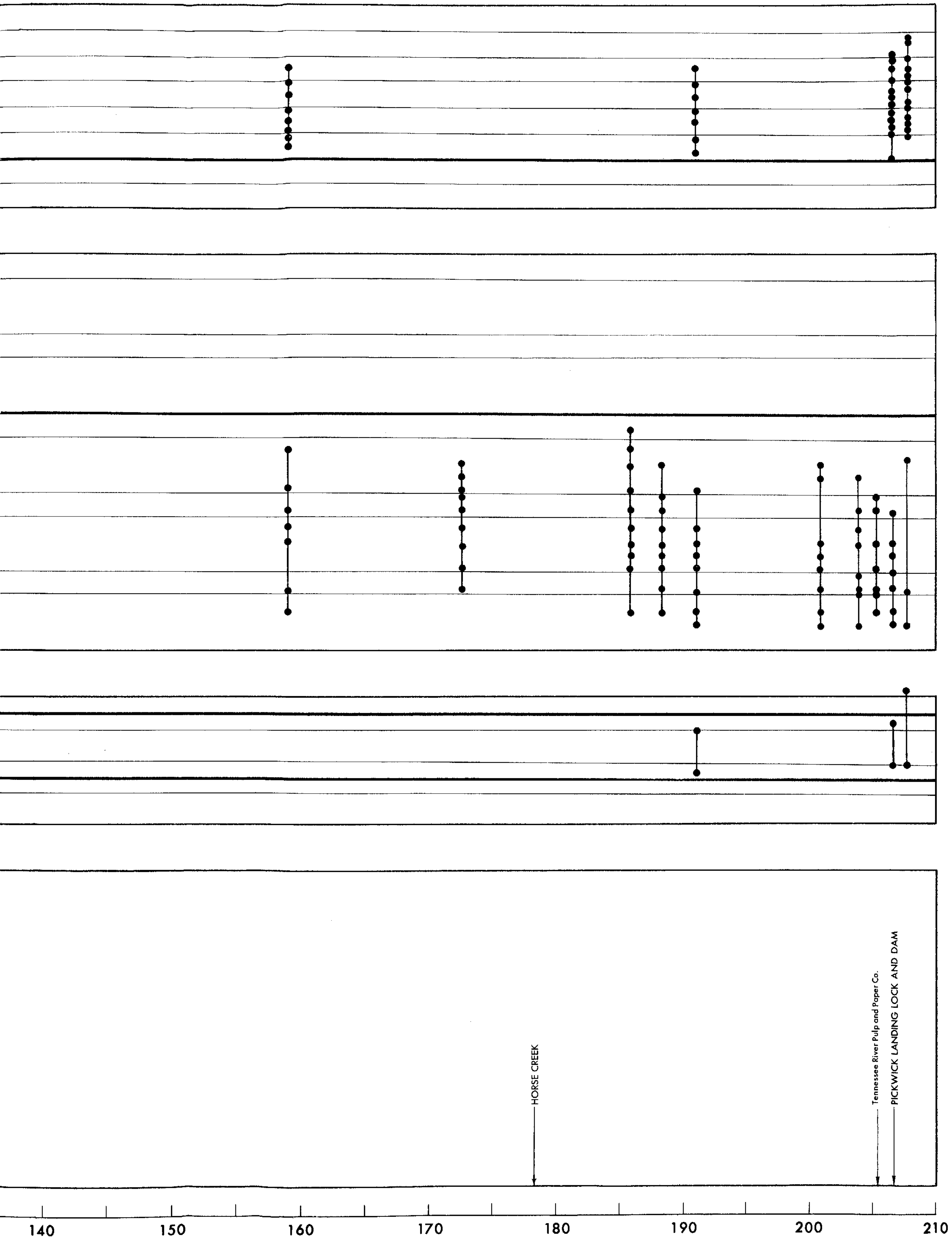


FIGURE XII-3



HORSE CREEK
Tennessee River Pulp and Paper Co.
PICKWICK LANDING LOCK AND DAM
140
150
160
170
180
190
200
210
TENNESSEE RIVER